POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
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Volume 72 NEW YORK, AUGUST 12, 1930 *Number 7*

The Operating and the Consulting Engineer

IT TAKES a broad-gaged man to admit that there are those who may know more about his particular job than he does, and to submit receptively to criticism of his practice and suggestion for its improvement.

And there has been much bitterness of spirit and many heartburnings because managers have called in advisers when extensions and improvements were in question or present efficiency was questioned.

Often there is too tortuous a path between the power plant and the office and too little appreciation on the part of those in authority of the practical knowledge and experience possessed by their own engineers.

They have not grown out of the one-time current conception of him as an often unprepossessing individual whose duty consisted in burning coal and keeping up the "speed" without much other knowledge than that necessary to operate more or less effectively the outfit with which he was furnished.

The more nearly the engineer conforms to that type the less likely he is to be taken into consultation and the more likely he is to resent it if he is not.

Where the engineer is really the recognized responsible head of the power department, an intelligent manager would hardly proceed toward changes in apparatus or practice without consulting him.

And such a man would welcome rather than resent the calling in of an expert to check his practice, ideas and suggestions or to present alternatives out of his study and experience and his wider knowledge of achievement and the available.

If the engineer's ideas were adopted even in part he would be gratified at having found favor with his employer. If the consulting engineer's prevailed they would have to be demonstrably superior, to the employer at least, and the engineer would probably recognize the reason for their being favored.

At all events he would have been recognized as a party in interest, would have had a chance to demonstrate his own grasp of the situation and would not have been ignored.

The qualified consulting engineer comes to the case without prejudice or preconceived notions, with facilities for analyzing the possibilities in all directions and with a view uncluttered with too close association with the present equipment and usage.

The engineer incumbent may, on the other hand, be able to suggest, out of the very intimacy of his knowledge of the plant and its operation, things that might not occur to the consultant working with a broader brush.

F. R. Low

EDITORIALS

High Use-Factor Means Lower Costs

DURING the past few years the effort to lower the cost of power by improving the thermal efficiency of station equipment has borne fruit to a remarkable degree. Reduction in operating cost is approaching theoretical limits, so that in lowering the cost of power greater opportunity now obtains in reducing the overhead by fuller use of equipment.

Average thermal efficiency for all stations has increased from ten or twelve to approximately seventeen per cent. Efficiencies close to twenty-seven per cent are obtained by the best of the modern stations. It has been estimated that 9,000 B.t.u. per kilowatt-hour is the minimum attainable from a high-pressure station, and probably another thousand heat units should be attained to cover limitations in practice.

A number of stations are now within twenty-five per cent of this minimum. Coal consumption per kilowatt-hour has been reduced to less than one pound. Pressures above the fourteen hundred pounds now in common use do not promise much better economy. More is expected from an increase of temperature, but the limit in fuel saving is rapidly approaching.

With the introduction of large units there have been savings in labor. Refinements in design have reduced the cost of lubrication and maintenance. Careful planning of station layout and the use of outdoor switch gear have lowered building cost. As high-pressure equipment is becoming standardized, initial cost is but little higher than for lower-pressure standards. And, furthermore, interconnection is making less reserve capacity necessary.

In raising the average plant up to the standard of the leaders, there is still plenty of opportunity for improvement in these respects. But not so with the stations in the van of progress. Here a yearly gain of a few hundred hours of operation of well-loaded equipment may mean more than the increment of thermal economy still attainable. Columbia, Long Beach, and, more recently, Powerton, are examples of what high use-factor does for commercial economy. Although these plants are operating at pressures between four hundred and six hundred pounds, they are proving more efficient than other stations with more favorable steam conditions but less uniform loading. They point to a very effective means of reducing the cost of power in modern practice. The greater the number of kilowatt-hours generated per kilowatt of installation, and the greater the hours of use, the lower will be the unit cost of power.

Endowing College Research

WHILE it is not unusual for industrials to endow fellowships for college research along specified lines, the real need is endowments for commercial research that will be of benefit to industry as a whole.

The Pennsylvania State College has for several years conducted research on oil-spray formation in Diesel injection systems. The burden has been a direct tax on the college funds and, as a consequence, the scope of the investigation has been narrowed to suit the breadth of the available funds. While one may reasonably argue that this work has more of the semblance of pure research and that when outlining the future program more attention should be given to the commercial aspect of the problem, nevertheless the Diesel engine and the oil-refinery industries would do well to support this work with a liberality heretofore not experienced by the college authorities.

The real problem confronting both the engine builder and the oil refiner is one of fuel supply. The requirements of the engine builders force the refiner to market a high-grade fuel oil, which entails an elevation in the fuel-cost level, and this is a detriment to the engine builder, for it narrows the field in which the oil engine is economical. The question, so far unanswered, is, What makes a good oil a good oil? Some engineers discourse more or less learnedly, or so it sounds, upon the relation of the Conradson to the total asphalt content; others declare it is the aromatic compounds that cause engine trouble. The fact is that nobody knows.

At present a committee is working on this evaluation of oil quality, but the tests are being run by different individuals with different engines under different conditions. Any results obtained must be strongly tinctured by the idiosyncrasies of the tester.

The oil refiner and engine builder would do well to examine the possibilities offered by an impartial research into the behavoir of fuel oil. The results of a year's intensive study of fuel oil probably would upset some present ideas; but, on the other hand, they undoubtedly would indicate the changes in design that are needed to adapt an engine to the cheaper grades of oil.

Natural Gas Under Power Boilers

THE QUESTION is frequently asked as to how and to what extent the present activity in natural-gas pipe-line extension will involve power boilers. That natural gas will largely displace coal in some favored localities and make substantial inroads in others is evident, but present indications are that its widest application will be in industrial and domestic furnaces and as fuel for heating boilers. For such uses it will find public favor as an aid to smoke abatement, even though the cost may be slightly more.

According to reports of the United States Geological Survey, nearly ten per cent of the utility power is now produced by gas. Judging from the number of such plants that have changed or are changing over to gas, this figure will probably reach twelve or fifteen per cent before long.

As for industrial power plants, judging from a survey of current gas rates and corresponding coal prices, it is unlikely that much natural gas will be burned under power boilers at distances greater than two hundred miles from the wells. Exceptions will be found in some large industrials whose consumption for all purposes is sufficient to warrant a rate that permits of the use of the gas under power boilers. Moreover, much of the distribution will be handled through the existing lines of local gas companies. Many of these are affiliated with electrical utilities, under which conditions it is unlikely that an effort would be made to build up a load competitive with the latter.

Natural gas has certain inherent advantages, such as flexibility of control, cleanliness within and without the boiler, ease on refractories, and smokelessness, all of which tend to reduce maintenance and hence are factors that will carry weight aside from price when making comparison with coal.

In short, one may look for an appreciable increase in the number of power boilers burning gas, but not to the extent that a superficial glance at the pipe-line extensions would indicate.

Heat Equivalent of a Kilowatt-Hour

STUDENTS of heat and power engineering cannot help but notice the discrepancies that exist in some of the fundamental heat-conversion factors given by authors of textbooks and handbooks. The heat equivalent of a kilowatt-hour is a notable example of inconsistency.

Two recently published handbooks disagree: The one, sponsored by an engineering society, gives 3,415 B.t.u. as the heat equivalent of a kilowatt-hour, the other, a recognized authority on mechanical engineering, gives 3,412 B.t.u. And the author of an excellent text on thermodynamics selected a compromise value of 3,413 B.t.u. The maximum difference is only three heat units; nevertheless, it should be possible to reach a closer agreement on the value of so fundamental an engineering factor.

The American Society of Mechanical Engineers has sponsored extensive research for the purpose of determining, within a fraction of a B.t.u., the exact heat content of steam. The value of this work will be largely lost if the discrepancies now existing in the value of heat equivalent of a kilowatt-hour are allowed to continue unchallenged.

The basis for a standard kilowatt-hour heat equivalent was agreed upon at the International Steam Table Conference, held in England, July 8, 1929. At this conference the kilocalorie was defined as 1/860 kilowatt-hour. From this definition and the B.t.u. equivalent of a kilocalorie it follows that 3,411.5 B.t.u. becomes an internationally acceptable value for engineering purposes. With this standard available the use of other values becomes inexcusable.

POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

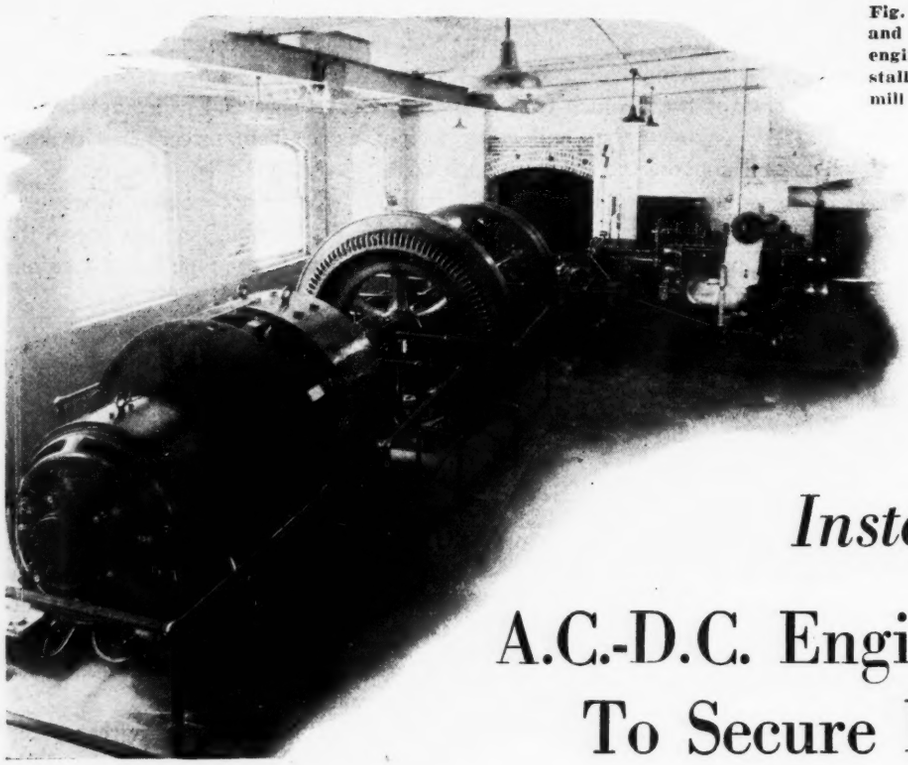

Fig. 1—The 540-hp. direct and alternating current engine-generator set installed at the Hammermill Paper Co., Erie, Pa.

Paper Mill *Installs* A.C.-D.C. Engine-Generator To Secure Heat Balance

THE Hammermill Paper Company is one of the well known manufacturers of business papers. Its plant at Erie, Pa., comprises a pulp plant, sulphite plant, and paper mill containing five paper machines.

The paper-making machines receive a pulp and water mixture that has a consistency of rather thin soup. This mixture passes over a fine wire screen, through which a large portion of the water is strained, on to a woolen felt on which it is carried between a number of rollers that press out more of the water. After the pressing process the film of pulp is passed successively over a number of steam-heated cylindrical dryers. The heat drives off the remaining moisture, and the paper is finished after passing between rolls that give it its finished surface. Thus the main function of the paper machine is to form the sheet and to separate the water from the pulp.

In general, two engines are used to drive each of the paper machines. One engine drives the paper machine auxiliaries, which travel at constant speed. The other engine drives the variable-speed sections of the paper machine proper. Exhaust steam from these two engines is used in the machine drying system, together with some additional live steam. In the past, no particular attention had been paid to the efficiency of these engines or to the power required to drive the paper machines and auxiliaries, as more steam was required for the drying processes than was ordinarily obtained from the exhaust of these engines.

The paper machine is driven by power from the direct-current generator, and the alternating-current load is adjusted so that the engine exhaust is just sufficient to meet the requirements of paper drying

It became necessary to install a new drive on one paper machine. A study was made of the various mechanical and electrical drives available and a decision was reached to install a sectional electrical drive using direct-current motors.

During the course of this investigation a heat-balance study revealed that a considerable saving could be obtained by the installation of the most efficient prime mover available, providing an arrangement could be worked out that would pass all the steam required for drying through this same prime mover and supply it as exhaust steam to the drying system. Such a scheme was developed and installed on one machine.

The engine belting and shafting driving the variable-speed sections of the machine were removed, and direct-current motor drives for the various sections of the paper machine were installed. This change eliminated a considerable amount of shafting, together with the maintenance work necessary to keep it in running condition, and also made more room available on the operating floor.

A 23½x24-in. 540-hp. uniflow engine operating at 200 r.p.m. and direct connected to a 250-kw., 2,300-volt, 60-cycle, alternator; and a 250-kw., 250-volt, direct-current generator and a 25-kw. excitor were installed. The direct-current generator supplies the current required by the motors driving the paper machine. The 250-kw. alternator operates in parallel with the main turbine-gen-

erators, that furnish the mill with alternating current.

The engine governor is mounted in the flywheel and is of the customary inertia type. Also mounted in the flywheel is the motor that regulates the tension in a spring opposing the action of the main governor spring. This motor, operated by a controller, is essentially a speed-changing device.

When starting the engine the motor is controlled by a hand-operated switch, and the speed of the engine is regulated until the alternating-current generator is synchronized with the generators in the power house. After the alternator has been connected in parallel with the power house, operation of the governor motors does not change the speed of the engine, since it must run at synchronous speed, but instead changes only the point of cut-off and the load carried by the alternator.

The engine is designed to operate with steam at 150 lb. pressure and 100 deg. superheat and exhaust at back pressures ranging from atmospheric to 25 lb. gage. The exhaust steam from this unit, together with the exhaust from the engine driving the constant-speed shaft, furnishes all the steam needed for drying the paper made by this machine.

The primary requisite in the operation of the unit is that it shall always furnish whatever exhaust steam is required by the driers in addition to the exhaust supplied by the constant-speed engine. This is accomplished by

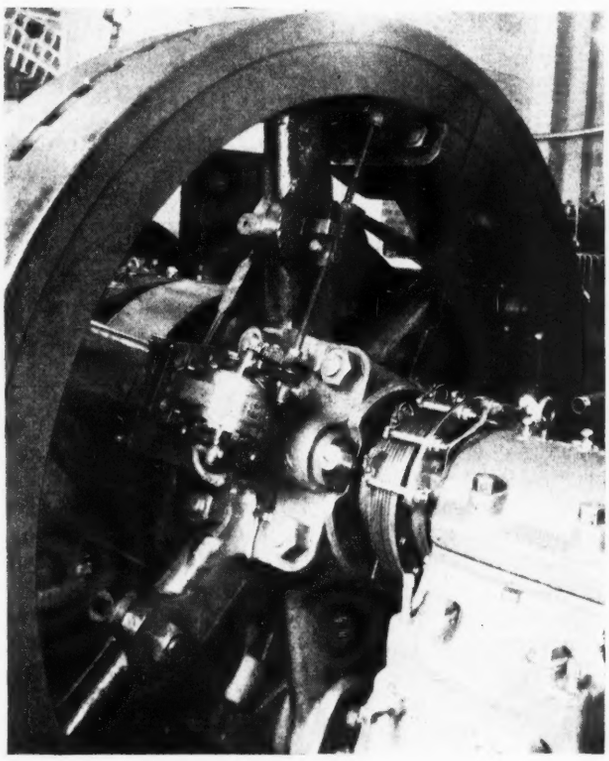

Fig. 2—Flywheel governor, showing speed changer motor, which is controlled by device shown in Fig. 3

maintaining the pressure in the drying system as required by the weight and kind of paper being made.

The direct-current load is determined by the power required to drive the paper machine, while the output of the alternator is the difference between the direct-current load and the total output of the engine as dictated by the quantity of steam required for drying.

Fig. 4 is a chart that illustrates how the heat balance is worked out. The intersection of the 10,000-lb. per hour exhaust line with the 15-lb.-pressure line shows that the total output of the uniflow engine must be 382 b.hp. Therefore, the intersections of the 382-b.hp. line with the line representing a 200-b.hp. direct-current load shows the load carried on the alternator to be 120 kilowatts.

Under certain operating conditions only 14,000 lb. of steam is required by the paper machines. As 10,000 lb. will be furnished by the constant-speed engine, the uniflow must in this case only supply 4,000 lb. When supplying this amount of steam, at, say, 10 lb. pressure, Fig. 4 shows the engine will develop only 175 b.hp., which is not sufficient to drive the paper machine. Under this condition the alternating-current generator acts as a

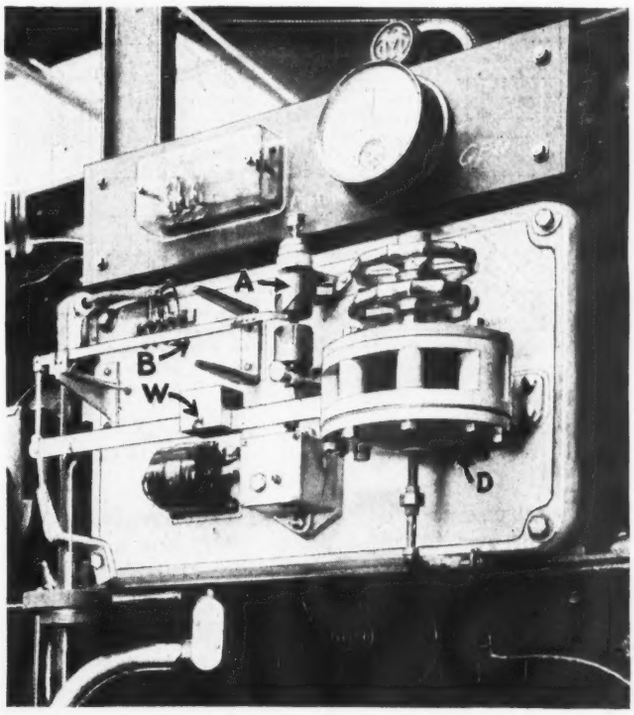

Fig. 3—Pressure actuated device for controlling the total load on the engine

synchronous motor, and furnishes the additional energy required.

It is evident that an automatic governing device for this unit must be arranged to maintain whatever steam pressure is required to dry the paper. Fig. 3 shows the control installed for this purpose on a panel of the paper machine. The diaphragm *D* is connected to the exhaust steam from the engines. Movement of this diaphragm caused by the exhaust steam pressure is opposed by a spring and the movable weight *W* on arm *B*. Drum *A* is operated by an electric motor and revolves slowly at about 2 r.p.m. When the exhaust steam pressure becomes greater than the pressure for which the regulator is set, arm *B* drops and makes an electric contact with the lower points on revolving drum *A*, thus operating the motor mounted in the uniflow engine flywheel and controlling the engine governor. This motor operates to decrease the cutoff, and, therefore, the amount of exhaust steam supplied for drying. Conversely, if the steam pressure drops, arm *B* rises, making contact with the upper points on the revolving drum, thus operating the governor motor in the opposite direction and so increasing the engine output of exhaust steam and power.

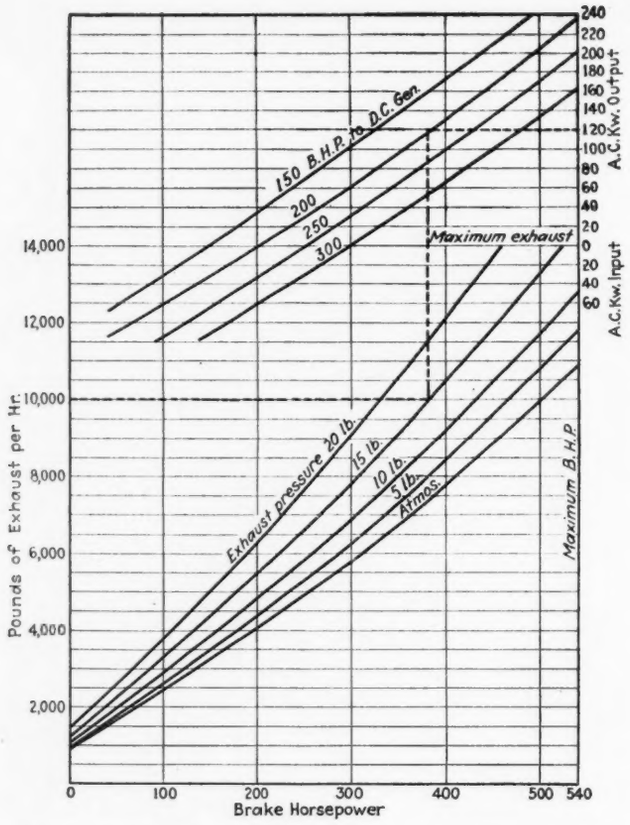

Fig. 4—Chart showing direct- and alternating-current loads required to produce a given amount of exhaust

The purpose of the revolving drum is to prevent hunting or over-travel of the control. For a slight increase or decrease in steam pressure arm *B* will make contact only at the tip of the points, and consequently operate the motor for a short time interval only. As the pressure variations become greater the time of contact becomes longer, thus running the governor motor for a longer period and producing larger increments of change in cut-off. The movable weight *W* allows the operator to adjust the regulator for whatever steam pressure is required to properly dry the particular kind of paper being made.

This flexible unit, with its accurate control of exhaust steam, has resulted in a direct saving of steam, as the alternating-current energy generated by it leaves that much less energy to be generated in the main power house, where over 80 per cent of the heat in the steam is lost to the condenser circulating water. The installation of electric drive on the paper machine has resulted in easier and more accurate speed control, and, in addition, has eliminated the complicated lineshaft previously used.

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HOTTER THAN HOT—What is believed to be the hottest spot in the universe was recently developed at the Westinghouse Research Laboratories by Ragnar Tanberg while investigating the characteristics of electric arcs in a vacuum.

In nearly a perfect vacuum, electricity created a spot of heat calculated to be 900,000 deg. F., approximately 90 times as hot as the sun. No thermometer could measure so high a temperature directly, so it was calculated by measuring the velocity of the molecules of the electrode metal that were "boiled away" by the intense heat.

Eliminating Waste in a Small Plant

BY H. C. DINGER
Captain U. S. Navy, Retired

SAVINGS by standardization, system, and avoidance of waste need not be confined to large plants. The results obtained in the power plant of the Naval Engineering Experiment Station prove that economies can be obtained in small plants as well as in large.

The engineering experiment station is situated on the opposite side of the Severn River from Annapolis, Md. The number of employees has varied in recent years from 125 to 150. The station develops its own power. Its maintenance, extensions, and manufacture of test equipment are done by the station force. The laboratory and clerical force numbers about 60, while the shop and maintenance force is about 80. Expenditures are about $225,000 a year, 12 per cent of which is for material.

During the past several years a special effort has been made to secure greater efficiency and to avoid waste in material. One of the first matters tending toward greater efficiency and improvement was the establishment of a definite system of monthly efficiency marks for all concerned. Marks are assigned by supervisors, checked by management, and results posted each month. Employees are given to understand that promotion and increases in pay will be gaged largely by their efficiency marks. This system has noticeably improved the morale.

A BETTER VACUUM HELPED

The largest single item where it was thought material savings could be accomplished was in the generation of power. There are one Yarrow express and one B. & W. boiler fitted for coal burning, and one Colven three-drum express burning oil. Electric current is developed by two steam turbine-generators during the day and by a Fairbanks-Morse 50-kw. Diesel set at night. In the past particular attention had been paid to the vacuum carried. By minor changes in operation of turbines, it was found that about 23 or 24 in. vacuum could be carried on the turbines, instead of the 10 in. with the same auxiliary condenser, which also handled drains, etc. Air leaks were found in the exhaust lines, and as soon as these were made tight the vacuum improved. This resulted in a material reduction in fuel and made it possible usually to carry the station and test loads with one boiler instead of two. As a further improvement, an available air ejector was installed on the condenser, and a vacuum 25 in. can now be carried.

The coal, delivered in barges, was unloaded by contract, which was not expeditious. The station had two portable gasoline-driven unloaders and three trucks, and it was determined to do the unloading with the station force. An electric motor was installed in one of the unloaders, replacing the gasoline engine; this doubled its capacity, besides giving a more reliable drive, free from delays. The coal had been unloaded from barges to open storage some distance from the boiler house and then from day to day was brought by truck to the boiler house floor. By clearing out a storage space adjacent to the boilers, it was found that coal could be stored there and the double handling avoided.

The coal had always been brought from the coal pile to the furnaces by wheelbarrows. The station had a small electric Buda truck. This was fitted with a ½-ton hopper, so that it could be used to bring in coal, saving

much labor and reducing by 50 per cent the cost of handling coal to the furnaces.

The demand for steam and electric power is extremely variable, on account of variation in testing work. There is, however, a certain base load both for steam and electricity. The steam load for operating auxiliaries, heating, etc., requires about 4 tons of coal per day but when some large steam test is under way, a demand for steam three or four times this amount may exist. Two Diesel engines have been installed, one being an engine removed from a German submarine. This unit is capable of giving 300 k.w. at 220 volts. There is also a four-cylinder 100-kw. Nelseco Diesel generating set.

Under some conditions the Nelseco set will carry the electrical load. But when the load is heavy, either the larger Diesel or the Nelseco with the Fairbanks-Morse set is required. For very heavy loads, the two larger Diesels are used.

Summer Operation

The Fairbanks-Morse 50 kw. unit handles the night and week-end loads. On night shifts the demands for steam from the boiler are relatively low. In summer time the boiler can be lightly fired, or banked outside of working hours. The use of this small Diesel obviates the need for operating a turbine-generator at low load, and requires a minimum of attendance outside of the regular working period. The Diesels' taking the day load enables the station to handle its steam load with only one boiler, thus saving the trouble and expense of starting an extra boiler for only occasional periods of short duration. The presence of both coal-burning and oil-burning boilers enables cheaper fuel to be used.

When necessary, or when the large Diesel is being overhauled, the turbine-generator is used. This gives fair economical results when operated at fairly high-loads, but at low loads falls off a great deal in economy. On the other hand, the Diesel engines will operate at high economy at low as well as at high loads.

This combination of boilers and Diesel engines allows great variations in demand for steam and power to be taken care of economically and with minimum attendance.

Exhaust steam is used for winter heating; in the summer it is also used to supply distilled water for make-up feed and other purposes.

The large Diesel generator set and the Nelseco engine are salvaged material and therefore represent no actual capital charge. Considerable money had to be spent, however, in overhauling the engines, installing them, and getting them in shape for efficient performance.

Low-Grade Oil Used

It was found that the two large Diesel engines could be satisfactorily operated on centrifuged Bunker oil. This oil is materially cheaper than the Navy Diesel fuel oil and is the same oil as is used in various special furnaces at the station. It must be heated in winter. Bunker C fuel for boiler burners is used rather than Bunker A, which costs about 20 per cent more. Although this will involve some special storage tanks and piping, the difference in cost of the fuel oil will net a substantial saving. In very cold weather sufficient lighter oil can be mixed with the Bunker C to enable it to be pumped without difficulty. Ordinarily, it can be handled with the existing piping and heating system.

The six firemen's cottages, at some distance from main plant, were not provided with heating. An old steam-launch boiler was installed as a central hot-water heating plant for the six cottages. This results in saving considerable fuel and improves the habitability of the cottages.

There is available from certain erosion and packing test machines considerable high-pressure exhaust steam, which ordinarily is more than necessary for heating purposes. To better utilize this heat a junked feed-water heater was repaired and installed in series with the existing feed heater. The auxiliary exhaust line was separated into two parts, with a regulating relief valve set at 30 lb. pressure dividing the two sections. High-pressure exhaust is dumped into the high-pressure part and passes to the regular high-pressure heater, giving 250 deg. F. to the feed. This high-pressure heater drains to the low-pressure heater, which takes the remainder of the exhaust steam, at about 5 lb. pressure, and gives a feed temperature of about 200 deg. F. In case the pressure in the high-pressure part of the exhaust line rises above 30 lb., the relief valve operates and allows this steam to go into the low-pressure side of the exhaust line.

Thus a feed temperature of 250-265 deg. F. instead of 200 deg., is maintained using the same auxiliary exhaust as before.

Exhaust steam is used for heating the buildings. By minor changes in piping arrangements, the condensate from the steam heating system, together with some of the steam trap discharges, is being collected in an elevated heating tank that is vented to atmosphere and supplies the hot-water radiators. A vacuum suction pump draws the condensate from the steam heating coils and discharges it to the water-heating tank or radiators. The hot water tank is available to supply hot water to wash rooms, etc. In this way the hot-water system heats a portion of the buildings and avoids unnecessary heating of the hot well. This rearrangement of the heating system is a fuel saver and makes it unnecessary to use live steam when the amount of auxiliary exhaust is below normal.

Instruments Aid in Economy

Proper use of CO_2 recorders, smoke indicators, thermometers in the fuel-oil line and in uptakes, and carefully going over boiler casings to plug up air leaks and make proper additions to the heat insulation on boiler casings and steam piping, has effected minor improvements in economy. A drive to have the firemen maintain proper CO_2, together with limited smoke, has shown material results. Considerable savings have been made by a more careful system of controlling feed-water condition and keeping oil out of the boilers to avoid extensive tube cleaning and renewal. The cost of power has been progressively lowered until it is now about one-half what it was three years ago, taking into consideration not only the fuel, but also the cost of labor.

By these various improvements the output of the plant has been increased materially, the earnings of employees, as a whole, have been increased; and the value of the plant has been increased and it has been placed in more efficient condition. In general, the intelligence of the personnel has been used to make labor more productive and to reduce material costs. Savings were devoted to increased output and higher pay. Co-operation has secured material advantages and waste has been avoided. The improvements and betterments have been carried out by utilizing the same basic annual appropriation without disturbance of the regular output, that is, the improvements have been made out of the savings.

CAPACITORS

IMPROVE POWER FACTOR

From 38 to 99.5 Per Cent

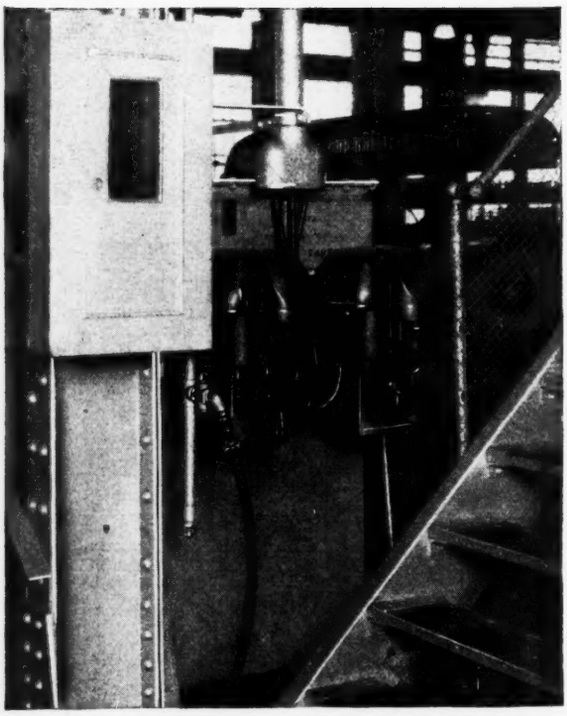


Fig. 1—Capacitor rated at 105-kva., 220 volts, divided in two sections of 70 and 35 kva.

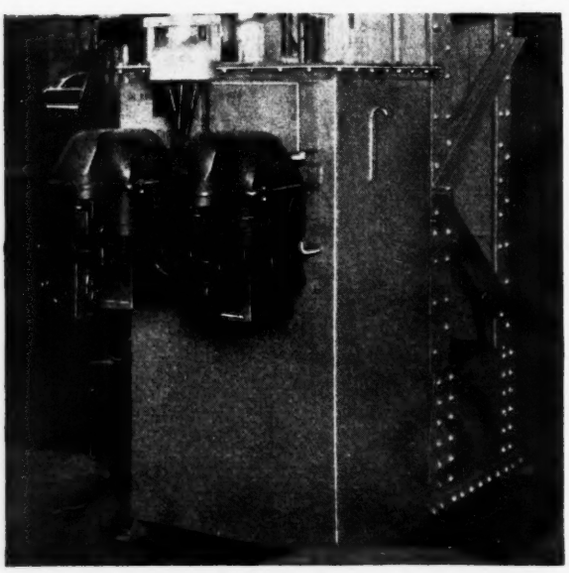


Fig. 2—The 90-kva. capacitor was provided with sectionalizing switches to permit of operation at one-third two-thirds, or full capacity

BY C. E. SWANSON
Engineer
Electric Machinery Manufacturing Co.

IN GENERAL, the correction of power factor in an industrial plant divides itself into three main groups: Plant correction, group correction, and individual motor correction. Each of these methods has its advantages and disadvantages, depending upon the condition and the results desired. In the plant correction method, the entire corrective kilovolt-ampere capacity is placed at the entrance of the power supply to the plant, usually on the secondary side of the transformer bank. This relieves the transformer bank of carrying the reactive power, but it does not correct the power factor of the system away from the transformers.

Group correction consists of applying the capacitor at a load center to correct the power factor of a group of induction motors. This method, in addition to the benefits of the plant correction, relieves the distribution lines of carrying the magnetizing current, thereby reducing the line losses, improving the voltage regulation, and enabling increased motor capacity to be carried by the feeder wires.

Individual-motor correction improves the power factor at its source. It places the capacitors at the motor terminals and eliminates the necessity for the conductors to carry the magnetizing current. This method improves the voltage at the motor terminals and aids considerably in effecting maximum motor speed and greater starting and pull-out torques with the induction motor.

Of the three methods, plant correction is less costly, because of the lower cost of a single large capacitor, but it is not so effective in improving the plant conditions. Individual motor correction is the most expensive, as well as the most effective. Group correction strikes a medium both as to first cost and to results realized. However, the method that will best apply to a particular plant is determined only after a thorough survey of plant conditions.

The Cincinnati Grinders, Inc., at Cincinnati, Ohio, had an extremely low power factor, approximately 35 per cent, caused by the many small induction motors operating machine tools that were underloaded a large portion of the time. Obviously, a large amount of magnetizing current had to be supplied to the motors through the transformers and distribution lines. This caused the three 50-kva., single-phase transformers and the distri-

bution circuits to be overloaded, and their efficiency to be materially decreased. In addition more motor capacity was needed for new equipment being installed.

Two solutions were possible: Larger transformers could be installed and the distribution lines enlarged to take care of the new load and provide for future expansion; or capacitors could be installed on the distribution lines to bring the power factor up to about 80 per cent. That would relieve the feeders and make them available for the increase in load. The capacitors would also bring the load on the transformers well below their rating and provide for future demands.

The first solution was cheaper by a considerable margin, but it had the disadvantage of not improving the power factor. There also was the possibility that the power company might at some future time incorporate a power factor penalty clause in its rates. This would require paying a penalty for low power factor or corrective equipment would have to be installed. Therefore, although the initial cost of the capacitors was somewhat higher, it was decided to install them.

Next, the type of correction had to be decided. Individual motor correction would improve the voltage regulation at the motor terminals, decrease the load on the distribution wires and transformer banks, and enable additional motor capacity to be carried by the present lines. However, individual motor correction was costly, owing to the number of small induction motors in the plant.

An alternate solution was group correction, which would relieve the distribution wires from carrying the entire magnetizing current required by the induction motors and would enable additional motor capacity to be carried by the feeders. While group correction would not correct the power factor on the lines from the capacitor to the individual motors, these lines would be comparatively short. Therefore, the additional benefits obtained by individual motor correction would be offset by the lower cost of the capacitors for the group-correction method. It was finally decided to install 240 kva. of capacitors in group correction. The capacitors were installed on three feeder circuits in sizes of 105, 90, and 45 kva. They were of the tank-type, for 220-volt, 60-cycle, 3-phase circuits, and built for indoor floor mounting.

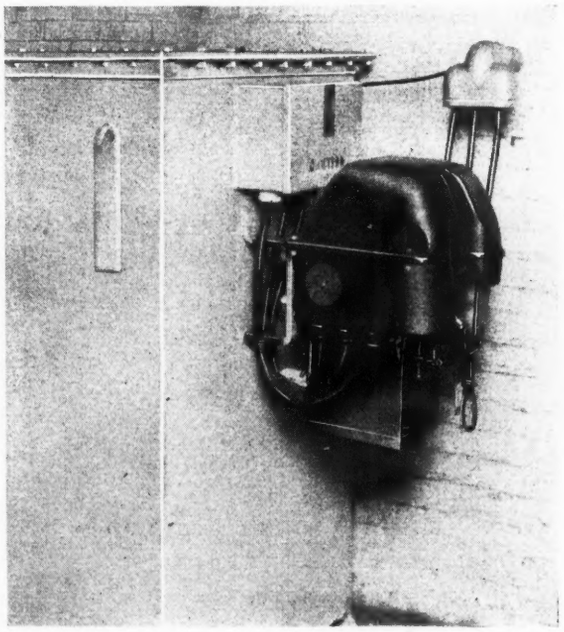


Fig. 3—On one feeder circuit with a constant load a 45-kva. capacitor was used

Decreased line and transformer losses, improved voltage conditions, and the installation of more motor capacity without increasing the size of transformers and distribution lines, are some of the results obtained. Correction in power factor also reduced the heating of the transformers and motors, and improved their operating conditions

In applying capacitors to this installation it was found that the full corrective kilovolt-amperes would not be required at all times, as the plant operates on part load during the night. It was necessary to work out an arrangement that would take care of the load variations during the different periods of the day without causing the feeders to operate at leading power factor. This was done by sectionalizing the two larger units, so that either one of them could operate at one-third, two-thirds, or full capacity. The amount of correction necessary could be determined by the number of machines in operation, the aim being to maintain a reasonably high power factor at all times.

The 105-kva. capacitor was divided into 70- and 35-kva. sections, so that it could operate at one-third, two-thirds, or full capacity, as the conditions on that feeder required. Likewise, the 90-kva. capacitor was split into 60- and 30-kva. sections. The 45-kva. capacitor was not split, because the load on its feeder was quite constant throughout the day.

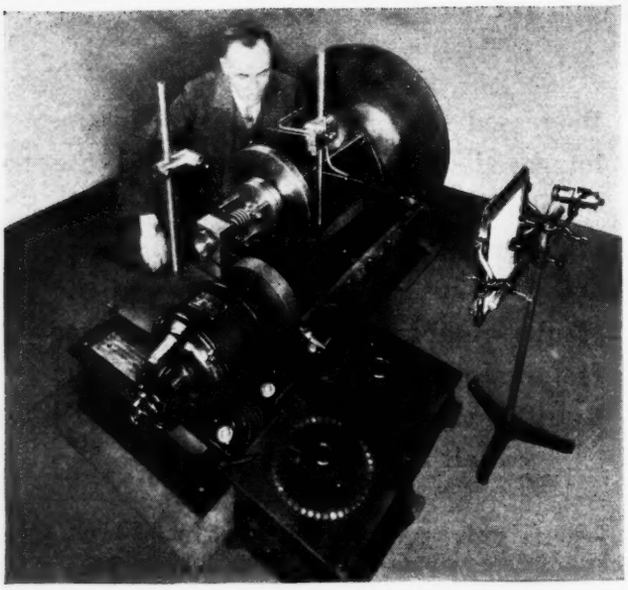
In the accompanying table is shown the power factor resulting from the different sections of the capacitors, beginning without any correction up to the point where the entire 240-kva. capacity is in operation. These results were taken from the feeder panel readings.

POWER FACTOR WITH VARIOUS CAPACITOR RATINGS

Capacitor, Kva. in Operation	Line Amperes	Reactive Kva.	Plant Load, Kw.	Volts	Plant P.F. Per cent
0	640	268	110	218	38
35	600	240	110	221	40
105	450	172	110	224	54
195	170	48	110	231	91.5
140	260	12	110	236	99.5

When the capacitors were installed the power factor was improved from 38 to between 90 and 99.5 per cent, depending upon the load. The voltage was increased from 218 to 236 volts, and the current reduced from 640 to 260 amperes.

Correction of the plant power factor did not enable the company to realize monetary gains from the savings effected, as the power company did not have a power factor clause in its power rates. However, it did reduce the losses in the transformers and distribution lines and thereby enabled additional motor capacity to be added without overloading the system. Further, a gain of 5 per cent in the transmission efficiency was obtained in the line from the local substation to the factory.



The Hartog vibration detector

Vibration Detector For Unbalanced Shafts

THE machine shown in the illustration was developed by Dr. J. P. Den Hartog, research engineer, Westinghouse Electric & Manufacturing Company, to study the exact behavior of torsional friction dampers, such as used on certain high-speed gas engines.

Torsional vibrations similar to those of an actual shaft in an internal-combustion engine are set up in the apparatus, and a record of them is shown upon a screen by light reflected from a moving mirror actuated by the vibrations. The magnitude of the vibrations is noted by observing the path of the light upon the screen. By using a friction damper, the torsional vibrations are reduced to a minimum, and this reduction is observed by photographing the path of the light beam. A theory was worked out by which it is now possible to calculate the amount of vibration with and without the damper attached.

Before this was possible dampers were often applied without having the correct propertions and adjustments, so that they did not act properly. A case which attracted wide publicity was the failure of the crankshafts of four of five engines of the Graf Zeppelin on one of its trips last year. Dampers had been applied, but incorrectly. After the failure, the German engineers made a complete investigation and corrected the trouble.

✦

A CORRECTION—In the article entitled "Oxygen Analysis in the Boiler Room," in the July 22 number of *Power*, it was stated (p. 137 third paragraph from the bottom, right-hand column) that dividing the number of cubic centimeters of solution by 18 equaled the cubic centimeters of oxygen per liter of sample. This was an error, the correct devisor being 10. Also, the statement (p. 138), "Dilute and thoroughly mix" should have read, "Dilute *to the mark* and thoroughly mix." References to thiosulphate solution indicated the prepared rather than the stock or dilute solution.

Elevator Rope Mileage Records Show Wide Variation

THE LIFE of elevator ropes varies widely and is influenced by many factors. Even on the same machine there is no consistency in rope life. One set of ropes may have a long life and the next a short, or vice versa. This is evident from the record of rope life given in the tables. These records were supplied by C. W. Naylor, chief engineer, Marshall Field & Company, Chicago, Ill., and are for a period from June, 1914, to December, 1929.

The elevators are of the direct-traction type, roped 1 to 1 on U-grooved sheaves. The traction sheaves are 36 in. in diameter and the secondary sheaves 33 in. in diameter, as in the figure. The cars operate on a 300-ft. lift at a speed of 600 ft. per minute. For the first seven floors the service is express without a stop, and from the seventh to the twenty-first floor local service is maintained. An average of about seventeen miles per day is made by each car except one, which runs about twenty-five miles.

From the car, the hoisting ropes run over the traction sheave, around the secondary sheave and over the traction sheave and to the counterweights. This bends the ropes the equivalent of six times per trip one way in the hoistway. In this installation there are 105 bends per mile. There is also a slight bend put into the ropes as they lead down over the secondary sheave to the counterweight. It might be well to state what is considered a bend in the ropes. Where the ropes bend into the traction sheave they change from a straight to a curved shape. Where the ropes lead off this sheave they bend from a curved to a straight condition. This constitutes a second bend. In other words, the ropes are bent twice in passing around a sheave. Then, in passing over the traction sheave twice and around the secondary sheave once they are bent six times. Therefore, when the car travels the length of the hoistway, all parts of the hoisting ropes passing over the sheaves are bent six times.

Conditions under which the elevators operate are favorable. The building is warm and clean, the hoistways are inclosed, and the ropes are kept well lubricated. During the war, inferior quality ropes were put on several of the machines.

The first two sets of rope used on each car were iron. All subsequent ropes have been mild steel. The hoisting ropes, Table I, are $\frac{5}{8}$ in. 6x19 construction.

TABLE I—HOISTING-ROPE MILEAGE, SIX ROPES PER SET

Car No.	Mileage, 1st Set	Mileage, 2d Set	Mileage, 3d Set	Mileage, 4th Set	Mileage, 5th Set	Mileage, 6th Set
	—⅝-In. 6x19 Iron—			—⅝-In. 6x19 Mild Steel—		
81	21,400	24,600	13,000	20,800	29,200	11,700
82	28,600	6,750	28,500	.....	.....	32,700
83	35,300	12,400	16,600	25,000	.....	7,300
84	28,000	44,800	.....	.....	.....	23,900
85	36,200	11,400	20,500	.....	.....	27,500
86	49,800	35,000	.....	.....	.....	14,000
87	36,200	13,000	16,600	16,100	.....	13,900
88	35,300	35,800	.....	.....	.....	26,200

TABLE II—COMPENSATING-ROPE MILEAGE, SIX ROPES PER SET

Car No.	Mileage, 1st Set	Mileage, 2d Set	Mileage, 3d Set	Mileage, 4th Set	Mileage, 5th Set	Mileage, 6th Set
	—⅝-In. 6x19 Iron—			—⅝-In. 6x19 Mild Steel—		
81	16,200	30,600	8,400	23,400	.....	42,000
82	13,000	16,100	13,600	14,300	30,200	9,300
83	13,000	13,000	30,000	30,000	.....	9,300
84	13,000	19,600	39,500	.....	.....	19,200
85	13,000	15,600	19,600	23,000	.....	25,400
86	16,000	14,000	18,100	21,000	.....	25,400
87	14,500	2,600	13,600	18,100	28,200	19,800
88	14,500	1,800	11,400	32,800	.....	36,400

TABLE III—CAR GOVERNOR-ROPE MILEAGE

Car No.	Mileage, 1st Rope (Tiller)	Mileage, 2d Rope (Tiller)	Mileage, 3d Rope	Mileage, 4th Rope (8x19 Steel)	Mileage, 6th Rope
81	7,800	5,800	32,500	48,000	26,000
82	7,800	33,200	29,000	.....	30,500
83	6,750	50,000	.....	.....	38,000
84	7,800	.....	.....	.....	89,000
85	8,809	81,600	.....	.....	6,000
86	7,800	37,500	21,800	.....	28,000
87	14,300	1,600	40,100	.....	41,000
88	14,800	35,100	.....	.....	46,000

TABLE IV—COUNTERWEIGHT GOVERNOR-ROPE MILEAGE

Car No.	Mileage, 1st Rope (Tiller)	Mileage, 2d Rope (Tiller)	Mileage, 3d Rope	Mileage, 4th Rope (8x19 Steel)	Mileage 5th Rope
81	63,000	41,000	.....	.....	18,000
82	9,800	16,000	.....	.....	70,000
83	6,800	33,300	20,800	.....	34,000
84	8,300	48,000	30,600	.....	9,000
85	11,400	55,000	.....	.....	30,000
86	9,800	16,000	15,000	44,000	6,000
87	57,000	.....	.....	.....	41,000
88	19,500	54,000	.....	.....	26,000

The iron ropes appear to have a longer life than the mild-steel ones, but it is too early to draw a definite conclusion.

For compensating ropes, Table II, the steel ropes seem to have a decided advantage over the iron. Rope life in this service is generally shorter than that of hoisting ropes. This would seem to indicate that the diameter of the sheaves has a marked effect on the life of the ropes. The compensating ropes run over a sheave 24 in. diameter, compared to 36-in. and 33-in. sheaves for the hoisting ropes. The hoisting ropes bend 105 times per mile, and the compensating rope bends 35 times per car-mile. Reducing the number of bends by two-thirds and the very light loading on the compensating rope did not seem to make up for the 12-in. difference in the diameters of the sheaves in the two services. One might draw the conclusion that sheave diameter is a more important factor in rope life than loading or the number of bends. Such an opinion, however, needs further evidence to support it. Conclusions on the life of wire ropes are difficult to substantiate on account of the long time required to get operating data.

The first set of hoisting ropes on the eight cars had an average life of 33,850 miles; the second set an average life of 23,000 miles, a decrease of over 10,000 miles. The average life of the first two sets of compensating cable was only 14,000 miles each. Although these ropes have a more consistent life than the hoisting ropes, they fall below them in length of service.

The governor's ropes, Tables III and IV, run over 18½-in. sheaves and are bent 35 times per car-mile. In this service the ½-in. 8x19 steel ropes appear to have an advantage over the iron tiller construction. Both classes of ropes have shown long life. Tiller rope used on the car governors had a maximum life of 81,600 miles. Steel rope in this service had, on Dec. 31 last year, a maximum life of 89,000 miles and was still in service. The governor ropes, like the hoisting and compensating ropes, show a variation in mileage life that is difficult to account for by operating conditions.

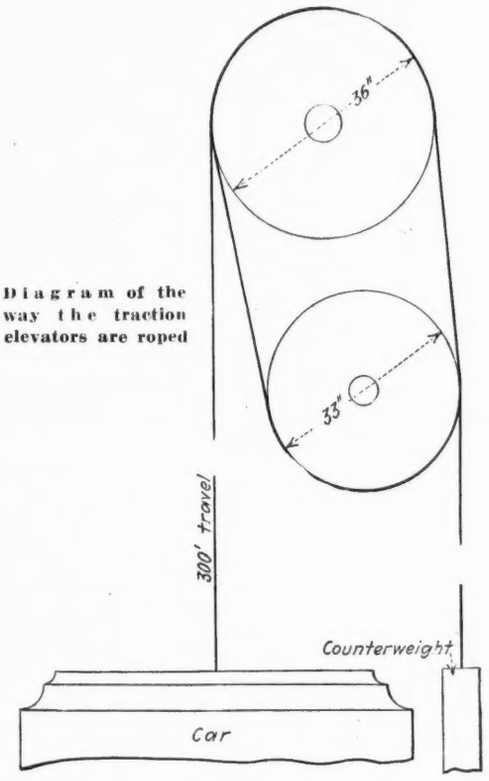


Diagram of the way the traction elevators are roped

The Modernity of the Ancient Engineer

ADVANCES made by engineers of the past confront the reader of any engineering history, but no example is so powerful as that given by the old steam plant of the Betchworth Quarries of England. Until it was recently replaced by an Ingersoll-Rand oil engine, a steam plant had supplied power to the quarries since 1873.

The interesting feature, however, is not this 56 years of activity, but the modernity of the engineering thinking embodied in the design of the power plant. As reported in *Compressed Air*, the power necessary to drive the machinery was furnished by a steam engine operating with steam at a pressure of 400 lb. per sq.in. It was a Perkins high-pressure compound unit built according to the patent of the late Loftus Perkins.

The boilers that generated this high-pressure steam were composed of heavy wrought-iron elements with welded ends, each tube being connected at each end by threaded wrought-iron nipples with left- and right-hand threads. Another interesting feature of the plant was the type of steam-pipe joint used. Known as the Perkins joint, it consisted of sockets having left- and right-hand threads so that the pipes screwed into the sockets had a *metal-to-metal* joint and were amply tight under even higher than operating pressures. The steam gage registered up to 1,000 lb. pressure, and the water gage was composed of *strips of mica* placed between heavy cast-iron plates. The level of the water could be seen by means of a lamp placed behind the mica strips.

The steam jackets around the high- and low-pressure cylinders were composed of a continuous coil of heavy wrought-iron tubing cast in the respective cylinders and coupled direct to the boiler. The engine operated on *distilled* water; and *no lubrication* was used in the cylinders, the piston rings being composed of a special mixture known as Perkins metal. No oil, therefore, contaminated the condenser or feed water. A Perkins patent evaporator supplied distilled water for make-up.

It would seem that this Perkins power plant embodies a number of disinctive features that are just now being reintroduced to meet present high-pressure conditions.

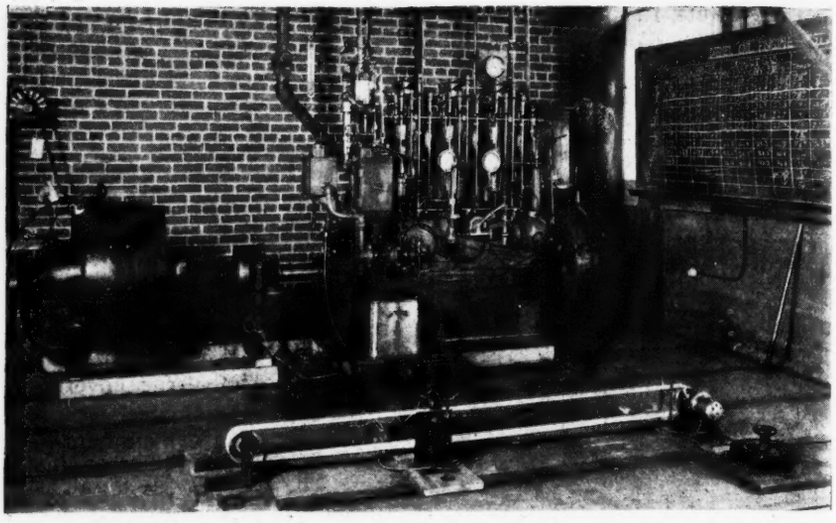


Fig. 1—The engine used in the tests by

W. E. JOHNSON

Torsional Deflection in Diesel Crankshafts

ONLY in comparatively recent years have vibration problems come emphatically before the engineer. The first research into the subject was made by Dr. Frahm of Germany. Since his time, with the increasing use of high-speed machinery, the problem is becoming increasingly important. While much has been written concerning the theory, few tests have been made to ascertain the actual deflection, with which this article deals.

A preliminary test was recently made at Oregon State College to determine the difference in angular distortion between the two ends of the crankshaft of a Diesel engine between no load and load conditions. The engine used in the test was a 30-hp., 450-r.p.m., 4-cycle, solid-injection, common-rail type. The firing order of the three cylinders was 1-2-3, at intervals of 240 degrees.

The test was not performed with the idea of getting very accurate results, but to obtain some idea of the amount of distortion that may be expected.

Apparatus Used in the Test

The apparatus used is pictured in Figs. 1 and 6, and is similar in principle to the equipment used in determining the muzzle velocity of projectiles. The belt was made of adding-machine paper of suitable weight, and had a speed range up to 4,000 ft. per minute. On each end of the crankshaft were fastened contact breakers, equally spaced and accurately aligned. The paper belt was arranged to pass over a ground bar connected in the secondary circuit. Two spark points, one for each end of the crankshaft, were aligned squarely across the belt and over the ground bar, leaving a spark gap of about $\frac{1}{8}$ in. The primary circuits were interrupted by each contact breaker as the crankshaft rotated. There were six breakers on each end, so that for one cycle of the engine twelve punctures were obtained in the paper belt for each end of the crankshaft.

As long as the crankshaft was not under stress, these punctures would remain in pairs, each pair being squarely in line across the belt. With the crankshaft distorted, each pair of punctures would be separated by a distance depending upon the speeds of the crankshaft and paper belt. Since the total distance between the first and last of twelve sets of punctures could be taken to represent 660 deg. at the crankshaft, the displacement between any two punctures of any corresponding pair could be taken as a direct measure of the displacement of the two ends in degrees.

Method of Checking Crank Positions

An engaging screw was placed on the camshaft and arranged so that the primary circuit could be closed just before No. 1 cylinder fired, and opened just before No. 1 fired again on the next cycle. By closing this switch with the engine running, twelve sets of punctures could be obtained in the paper belt, representing one cycle of the engine, each set giving the over-all distortion of the crankshaft.

Three different engine speeds were used in conducting this test, and at each speed belt readings were obtained at no load, half load, and full load. All readings were corrected to the no-load reading, and the no-load reading was used as the basis from which angular deflections were determined. This was done to eliminate possible errors due to unrefined apparatus. The results of the test therefore give the deflections as the difference between no-load and load conditions. By refining the apparatus, there would be no difficulty in obtaining readings of the absolute deflection. The expenditure was not

made on this test, however, because of its experimental nature.

The general results of the test were plotted as shown in Figs. 3, 4, and 5. It should be noted that it is possible to have the actual deflection one-half of that indicated, since at no load the crankshaft may be deflected in the opposite direction from its load position. From a study of all three sets of curves, it can be seen that the crankshaft was fairly free from vibration as No. 1 fired, that it vibrated badly as No. 2 fired, and was again somewhat steadier as No. 3 fired. The engine was loaded with a dynamometer, so that at each end of the crankshaft there was a steadying influence. This was particularly true of the flywheel end, especially at the higher speeds. As No. 2 fired, the effect was much the same as loading a very flexible beam at the center. This illustrates the fact that the nature of the external load is of great importance in any prime mover subject to vibration.

Conclusions Reached

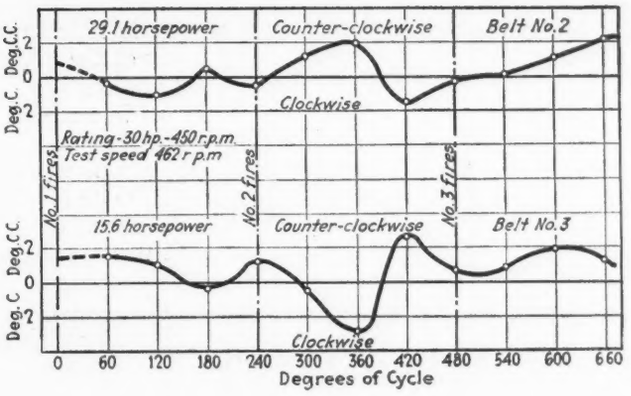
The general effect of higher speed seems to be that of dampening the vibrations. The impulses in a Diesel engine are, of course, potent sources of vibration. However, the magnitude of the initial impulse is nearly the same at any speed, whereas the inertia forces increase approximately with the square of the speed. The inertia forces oppose the power impulses, and apparently have their greatest effect at about 500 r.p.m. in dampening the vibrations.

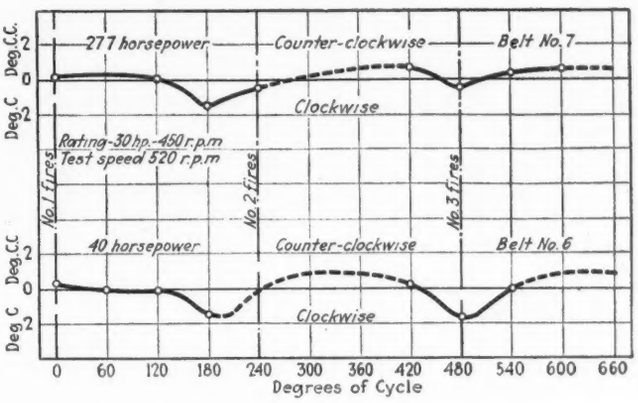
The elastic nature of the material is the fundamental cause of vibration. When the mass-space relations, combined with the elastic properties, are such that the power impulses coincide with the natural period of vibration of the shaft at a given speed, that speed is said to be critical. At that speed, the only limiting factors on the induced stress are the dampening effects. Dangerous stresses are often induced at a critical speed. On this engine, there seems to be a critical speed (although not a dangerous one), near the rated speed.

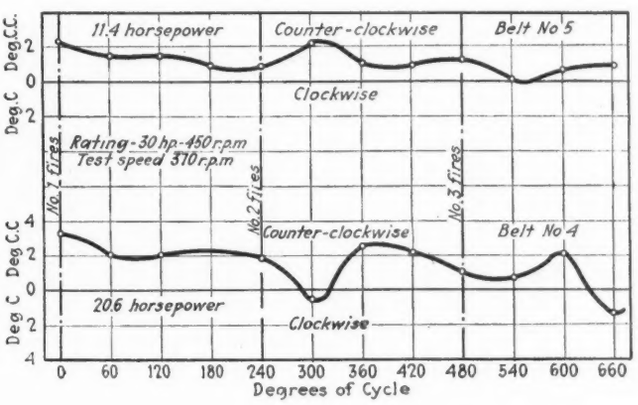
There may be any number of critical speeds outside of the speed range of the engine. However, the appearance of a critical speed near the rated speed of an engine is rather unfortunate. It is impossible to change the firing order of a three-cylinder engine to correct for this, since any firing order will be a progression from one end to the other. On a six-cylinder machine this condition would not exist. The critical speed is indicated in this case by the fact that the curves taken at 462 r.p.m. show the greatest number of fluctuations between clockwise and counter-clockwise twists.

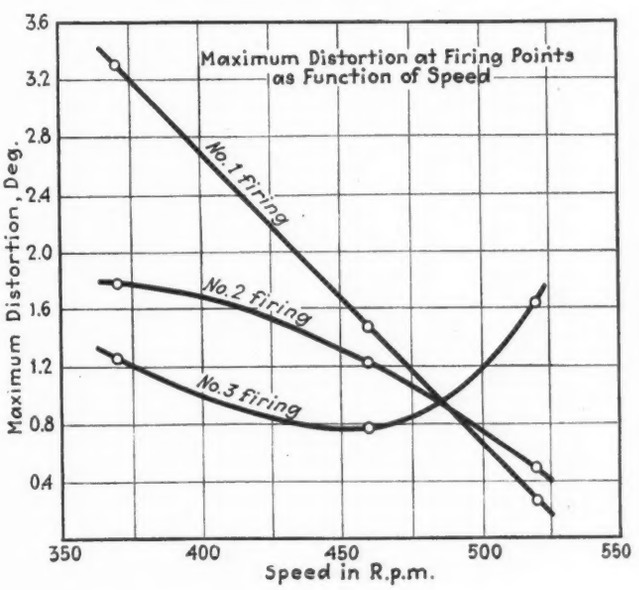
The distortion alone was not a measure of the vibration, for a large distortion may result at slow speed when the inertia forces are low and the impulse of No. 1 firing has practically nothing to retard it but the load. The best way to eliminate a critical speed is to redistribute the mass of the crankshaft, possibly making it heavier.

A further study of the curves shows that the distortion cause by No. 1's firing decreased rapidly with an increase in speed. This was undoubtedly caused by the increasing influence of the flywheel as the speed increased. On the other hand, No. 3 had a minimum distortion near the rated speed, and an increase at higher speeds. At the higher speeds, the load on the en-









Figs. 2 to 5 (reading from top to bottom) — Plotted results of the tests

gine was greater, and evidently the armature of the dynamometer had not sufficient flywheel effect to retard the impulse of No. 3 as it fired. A large part of the initial impulse had then to be absorbed by the flywheel distortion. When firing, No. 2 cylinder had an intermediate effect, although in general the deflection decreases as the speed increases. These derived results are plotted in Fig. 5, from which it can be seen that the distortion caused by the impulses was near the minimum at the rated speed, a satisfactory condition. At this speed the

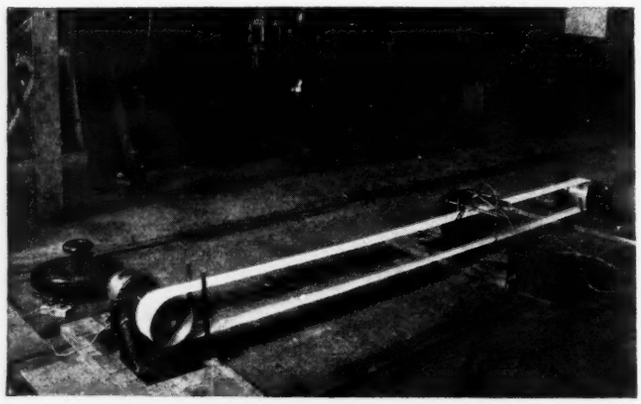


Fig. 6—Arrangement of belt and contact points

distortion values were nearly the same for any cylinder firing.

From the results of this test, it would seem that a crankshaft distortion of about two degrees on an engine of this type can readily be expected, in spite of the rather heavy construction of the crankshaft. A point worth remembering is that the stress induced will be at least that caused by the over-all deflection, since any added deflections between the two ends will result in the crankshaft's being under a greater deflection per unit length at some place in between.

Locating Ground Faults on Low-Voltage Circuits

By Robert Ball
Pittsburg, Calif.

USUALLY one conductor of an alternating-current lighting circuit is effectively grounded, as in Figs. 1 and 2. When a neutral is provided, it is grounded, Fig. 1. When only two conductors are employed one is grounded, Fig. 2. If a ground develops on either outside conductor, Fig. 1, the faulty conductor will be disconnected by the blowing of its fuse, providing that sufficient current flows. The grounded conductor should not be fused at any point and should be identified by a white outer braid.

It is important that control and relay circuits be kept free of grounds, otherwise interruptions to service may result. In Fig. 4 an elementary control circuit is shown with a lamp ground detector that is commonly used. The ground connection between the two lamps forms a neutral to which current will flow to any other ground. Thus if a ground develops at *A* current will flow from there to the connection between the lamps. Certain relays will operate on the current flowing through a 50-watt or larger lamp, and the opening or closing of a switch may result. A direct ground, as at *B*, will apply normal voltage to the relay coil.

On electric elevators and in connection with magnetic clutches, safety switches are connected in series, and are normally closed. Should two grounds develop, as in Fig. 3, opening switch *A* would not open the circuit, because of the shunt path provided by the grounds.

Although all conductors may be well insulated on an alternating-current system, voltage will usually be found to exist between each conductor and ground, as read on a voltmeter. These voltmeter readings are obtainable because the conductors and the earth act as plates of a condenser. On an extensive network, in which case the conductors and their insulation form elements of a condenser having large electrostatic capacity, full neutral voltage to ground may be indicated, and an appreciable current may flow. On a small system the condenser current may not be great enough to cause a voltmeter to indicate neutral voltage. Because of this condenser action a magneto will often ring through good insulation. Direct current will not flow through a condenser, hence it is used to measure insulation resistance.

Grounded conductors are caused by moisture, chemical action, heat, dirt, abrasion of insulation due to vibration or contraction and expension and by mechanical failure of the insulation produced by cutting, breaking, or crushing. So long as only one conductor is grounded immediate damage will not ordinarily result, yet it constitutes a serious hazard on a power circuit. As previously stated, one ground, where a lamp-type detector is employed, may cause the operation of sensitive control apparatus. This danger does not exist in the average industrial plant.

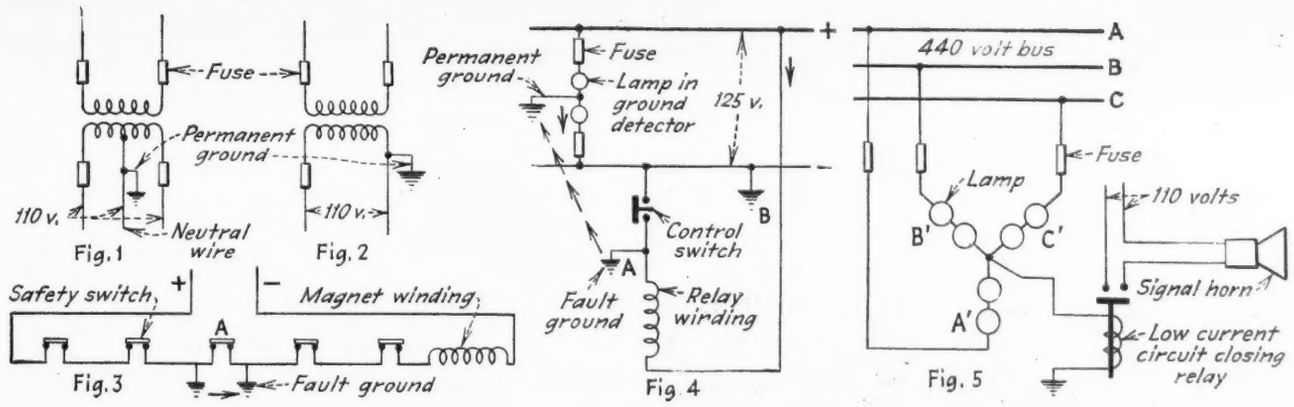
If, while one conductor is grounded, one of another phase or polarity also becomes grounded a short circuit results. This fault will cause immediate damage from arcing or burning until one ground is disconnected, which is usually accomplished automatically by the blowing of a fuse or the tripping of a circuit breaker.

Lamp-type ground detectors are widely used because they are cheap, reliable, and quite sensitive. Low-wattage lamps give the most sensitive indications; they reduce the current that can flow from the detector's neutral, and require small power. Ground detectors are valueless on circuits that are normally grounded, since they will continuously indicate the voltage that exists between any conductor and ground.

In Fig. 4 is a lamp-type ground detector suitable for use on a two-conductor ungrounded circuit. Fig. 5 shows a similar type of ground detector connected to a three-phase circuit. The detector's neutral is grounded through a relay to sound the horn when a ground exists, thus giving immediate warning. If a recording ammeter is connected in series with the detector's neutral a record of grounds will be automatically obtained.

All of the lamps used in a ground detector must have similar characteristics, otherwise indications will be misleading. A partial ground will cause one lamp or series group to burn dim, while the other lamps will increase in brightness. A dead ground will cause the lamps connected to the grounded conductor to become dark. Fluctuating indicators usually denote a ground resulting from moisture; but vibration will cause similar indications if a conductor's insulation fails.

The location of a ground cannot be determined from a detector's indications, therefore, when a ground occurs, feeders are momentarily disconnected until one is found which, while disconnected, clears the ground. After



FIGS. 1 TO 5—DIAGRAMS SHOWING LOCATION OF GROUNDS AND GROUND DETECTORS

Fig. 1—Permanent ground on the neutral of a 3-wire system. Fig. 2—Permanent ground on one side of a 2-wire system. Fig. 3—The two fault grounds short circuit control switch A. Fig. 4—Lamp ground detector connected for use on a 2-wire system. Fig. 5—Lamp ground detector and signal horn connected to a 3-phase system.

the faulty feeder is found, branches from it are next tested. Finally each piece of equipment connected to the faulty branch feeder is momentarily disconnected until the ground is located. This testing is generally done at a time, say at night, when the momentary interruptions will cause least inconvenience and loss of production. A portable ground detector may be used when testing is done out of view of the permanent ground detector, or, in the case of heavy grounds, test lamps connected as shown in Fig. 6 give reliable indications. In Fig. 6 conductor *A* is grounded, therefore the test lamps connected between it and the ground will remain dark until the three-pole switch is opened. When the ground is cleared by opening this switch the test lamps will glow at approximately neutral voltage. If there is reason to suspect that a ground exists on a certain feeder it should be disconnected first. Otherwise, feeders exposed to unusual dampness, heat, or that have been longest in service, should be tested in the order named.

When possible the cause of a ground should be ascertained, and steps taken to see that similar faults are prevented. Usually a ground can be cleared by applying insulation at the point of breakdown, but in some cases, as when insulation has become water-soaked or damaged by heat, it is well to replace the conductors affected.

Grounds can largely be prevented by careful workmanship and by following approved methods during installation. It is important that insulation not be damaged when conductors are drawn into conduits, and that conductor insulation be permanently kept away from rough or sharp edges. Porcelain conduit covers prevent damage to the insulation of conductors at outlets. A point of failure is eliminated when the conductors are wrapped with heavy fabric, such as canvas, where they leave a conduit that is not terminated in a fitting provided with a porcelain cover. Such a wrapping prevents damage to insulation, especially where the conductors are heavy, and partly supported by the conduit.

Conduits into which water may enter should be sealed by, first, packing insulating material about the conductors, then pouring about ½ in. of hot insulating compound into the end of the conduit. When cold the surface of the compound should be flush with the end of the conduit bushing, and should be waterproof. In moist locations and below floor levels conduit fittings and junction boxes must be reasonably water tight, for moisture is a common cause of insulation failures.

The temperature of rubber insulation, which is almost universally used for low-voltage conductors, must not exceed 150 deg. F. if rapid deterioration is to be prevented. Excessive heating will arise from overloading and from faulty connections or splices. In hot locations, as around boilers, conductors should be provided with slow-burning or asbestos insulation. Insulation composed largely of asbestos absorbs moisture readily, therefore it must be kept dry.

Splices must be permanently electrically sound, and the insulation about them should be a little greater than that of the conductors. Varnished-cambric tape covered with two or three layers of friction tape half lapped affords dependable insulation, especially if the completed splice is well painted. Narrow strips of tape should be used on splices of small conductors.

In conduit fittings, junction boxes, switch cabinets, compensators, and at motor terminals and the like, conductors should be quite long, not only to facilitate making connections, but also to enable repairs and inspec-

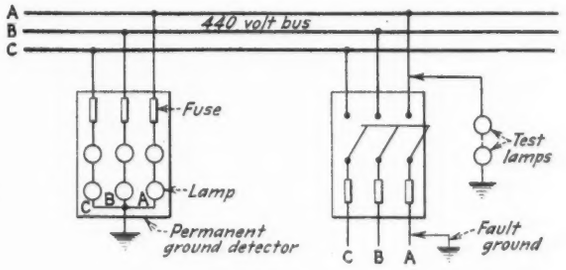


Fig. 6—Diagram of a ground detector and a fault ground on a 3-phase line

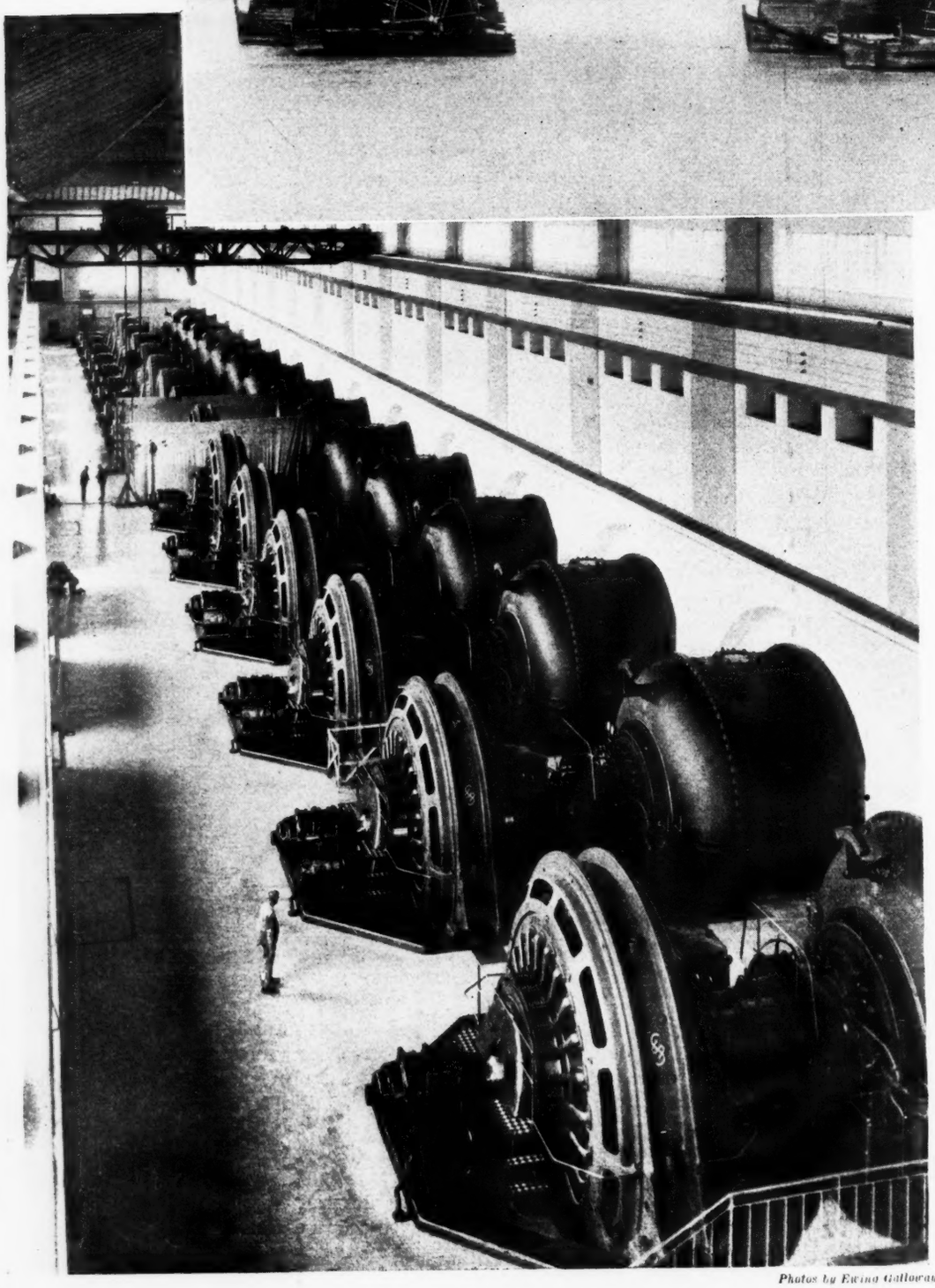
tions to be conveniently made. Frequently, in an attempt for neatness, conductors are cut without allowance for slack. Conduits and their fittings must not be overcrowded with conductors, and care must be taken to see that the covers and screws of fittings never damage insulation.

If electrical installations are made in conformity with the national electrical code there is little likelihood of grounds or similar faults developing. Installations that do not conform to the code should be revamped.

Many grounds develop gradually and may exist for a considerable period without giving any indication on a lamp-type detector. Their existence would be disclosed by periodically checking all circuits with a sensitive insulation tester, such as a megohm meter, and this should be done on all installations where the greatest reliability is necessary.

A Hydro Contrast

Stream wheels, floated on the blue Danube, are inefficient but picturesque



Fifteen turbines on the River Inn, Bavaria, generate a total of 100,000 hp.

Photos by Ewing Galloway

REDUCING *the Heating System's* STEAM CONSUMPTION

By CHARLES L. HUBBARD

A pound of steam used for heating buildings costs practically the same as a pound of steam used for power generation or any other purposes, and it is therefore just as important to be economical of its use. Some of the things that will help decrease the steam used for building heating are here suggested

WHERE ALL combined power and heating plants make use of exhaust steam for warming buildings the mistake is sometimes made of considering this steam a waste product and ignoring the importance of using it economically. As long as there is a surplus which cannot possibly be utilized there is a certain amount of truth in this view, but it requires a given amount of fuel to generate a unit of heat regardless of whether it appears in the form of live steam or exhaust, and as soon as the supply of the latter falls below the demand, it is just as valuable for heating purposes as live steam drawn from the boilers to make up a deficiency, and should be used with care.

Methods for improving the efficiency of a heating system will vary with the type and operating conditions. Heating plants without power equipment are comparatively simple, and reducing operating costs consists chiefly of eliminating leaks; increasing the rapidity of steam circulation and effectiveness of air removal; regrading of pipe lines and cutting out pockets where condensation accumulates; putting the insulation in good condition; and perhaps most important of all, both as regards economy of operation and comfort of the occupants, the installation of an effective system of temperature regulation, preferably automatic, or at least one which is under the control of the operating engineer.

When the heating system is combined with a power plant, the problem becomes more complex, owing to the possibility of using exhaust steam for heating and also for process work. While the details noted in connection with a simple heating system also hold in this case, the most important factor is that of utilizing the greatest amount of exhaust steam in case of an existing non-condensing plant, or of arranging the equipment in a new or remodeled one so as to secure the most economical heat balance. This is not an easy matter, because both the power and heating requirements are variable quantities, particularly the latter, which not only varies greatly at different seasons of the year, but also from day to day.

Thus far attention has been called only to the matter of fuel economy and the saving that can be effected by improvements in equipment. Of even greater importance are the effects of proper heating and ventilating upon operating conditions and the manufactured product.

In a series of experiments carried out some time ago by the American Society of Heating and Ventilating Engineers at its Pittsburgh laboratory it was found that varying the relation between temperature and humidity of the air had a marked effect upon the endurance of people engaged in active physical work, particularly at abnormally high temperatures. For example, at 100 deg. it was found that a person was able to do four times as much work when the relative humidity was 30 per cent as was possible after it had been raised to 100 per cent. This series of tests was made to cover a wide range of conditions, and the results are available to any manufacturer who wishes to know the best combination of temperature, humidity, and air motion for the highest working efficiency where one or more of these factors is fixed or its range limited.

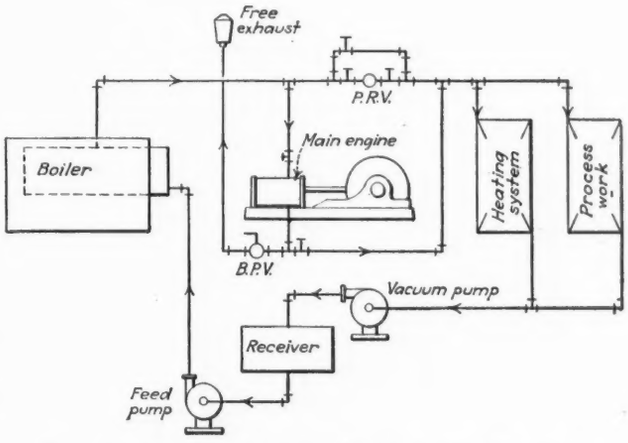


Fig. 1 — Non-condensing power plant combined with heating system

Data of this kind will be found particularly useful in special industries and departments where air conditions are out of the ordinary. With the recent advancement in "air conditioning," and the standard equipment now available, it is not difficult to obtain a comfortable working atmosphere in many occupations that otherwise would prove both uncomfortable and unhealthful. Anything that improves the comfort and health of an operative increases his efficiency, reduces loss of time due to sickness, and tends to cut the cost of production.

Investigations by the New York State Commission on Ventilation showed that an increase in room temper-

ature, from 68 to 75 deg. might be accompanied by a decrease in the amount of work performed amounting to 15 per cent, while a further increase to 86 deg. caused a decrease of 28 per cent. In that connection it is interesting to note that an investigation of a considerable number of industrial establishments of various kinds in New York State showed that 72 per cent of the workrooms were at a temperature over 72 deg. and 29 per cent over 79 deg. The average office building, unless equipped with automatic control, is nearly always overheated except in the coldest weather. Thus in this type of building, normally in charge of an operating engineer, there is an opportunity for a decided improvement in the efficiency of the occupants by properly controlling the temperature, which at the same time cuts down the fuel cost, effecting a saving in two ways.

Particular advantages are to be gained by suitable air conditioning in connection with various manufacturing plants, such as textile mills, printing plants, bakeries, candy kitchens, laundries, etc., all of which present definite individual problems. For example, in spinning rooms 75 deg. and 65 per cent humidity have been found to give the best results; in match factories 68 deg. dry bulb and 55 deg. wet bulb permit of continuous operation and reduce fire hazards; in candy-dipping rooms 66 deg. dry bulb and 50 per cent relative humidity give a high-quality product.

One of the first steps toward improving heating systems already in use is to see that the radiators and coils are properly air vented, that steam circulation is positive, and that condensation is returned to the receiving tank without water-hammer or singing in any part of the system. If there is difficulty in one or more of these, it is usually best to remove the air valves, replace the return valves on the radiators with thermostatic or other forms of automatic valves, and attach a vacuum pump to the main return. This not only takes care of the items noted above, but also eliminates difficulties from

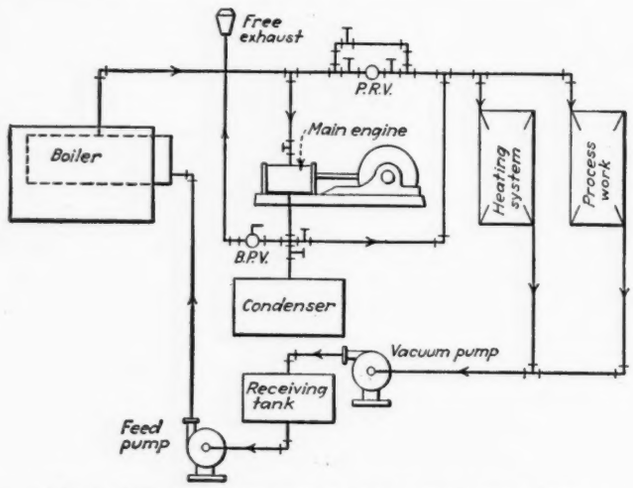


Fig. 2—Heating system supplied with steam from a power plant arranged for both non-condensing and condensing operation

improperly graded steam and return pipes, and prevents short circuiting with its holding back of condensation in certain lines.

While uncovered pipes may serve as radiating surface, they are not usually located where needed for this purpose, so that the heat they give off is largely wasted. Covering a steam pipe saves from 85 to 90 per cent of the heat lost from the bare pipe. Waste of fuel through leakage of steam around pistons, valve stems, at imperfect joints, and through the blowing of steam from small drips to the atmosphere is hardly ever realized, and none of these losses should be allowed to continue in a well-managed plant.

In manufacturing buildings of considerable height, particularly those of the monitor-roof type heated by direct radiation, there is a large amount of fuel wasted by overheating the upper part of the building. In cases of this kind the hot air rises directly upward to the ceiling or roof, leaving the floor zone too cold for comfort. Investigations have shown that in a room 10 ft.

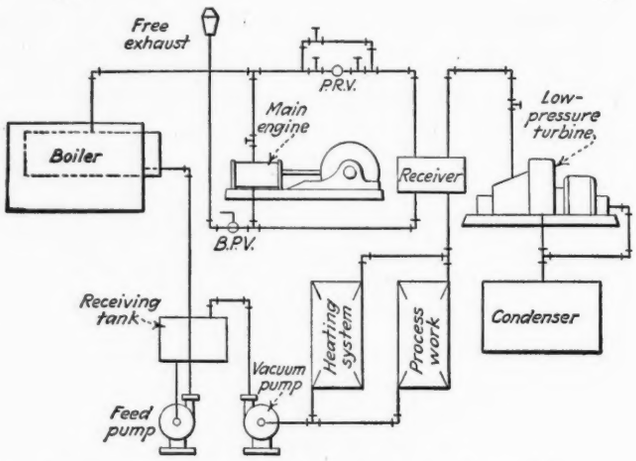


Fig. 3—Combination of non-condensing engine and low-pressure turbine with heating system

high there may be a temperature difference of 20 deg. between the floor and ceiling, and this difference increases with the height of the room. Aside from the matter of comfort, this condition greatly increases the heat loss through the roof, and by equalizing the temperature in the room the fuel bill may frequently be reduced from 10 to 20 per cent.

An effective way of doing this in industrial buildings is to substitute hot air for direct radiation, blowing it horizontally, or slightly downward, through outlets eight or ten feet from the floor. An arrangement of this kind will maintain a comfortable temperature in the working zone and prevent overheating in the upper part of the room, thus increasing the comfort of the occupants and reducing the waste of heat at the same time. Unit heaters will often solve this problem in a simple and comparatively inexpensive manner.

A source of heat loss the magnitude of which is not always fully appreciated is that due to the leakage or infiltration of air around window frames and sashes. In the case of modern iron sashes, particularly those used in the construction of industrial buildings, this loss is reduced to its lowest practical point, but in all types of buildings equipped with ordinary wooden sash the heat lost through leakage reaches a large figure, especially in windy weather. While the greatest loss occurs around the sash and across the meeting rail, there is also considerable leakage between the window frame and wall in buildings of brick and concrete construction.

Extensive tests have been made to determine these losses, and the following figures, based on these investigations, correspond approximately with actual conditions. These data are for an average wind velocity of 15 miles an hour, and represent the heat loss in B.t.u. per hour per foot of crack for a temperature difference of 70 deg.: Uncalked crack around frame, 28.7 B.t.u.; plain non-weather-stripped window, 157 B.t.u. By suit-

able calking practically all leakage around the frame can be eliminated, and a good weather strip will reduce the loss around the sash to about 29 B.t.u. In case of high winds of 50 miles an hour, the above figures will become 114, 492, and 148 B.t.u., respectively.

Although a moderate amount of air leakage is desirable in unventilated buildings, the results common with non-weather-stripped window sashes are far beyond any ordinary requirement and are very wasteful in the use of fuel.

While arrangements for securing the most efficient heat balance must be worked out for each individual plant, there are general schemes that may be used as a basis, and some of these are shown in Figs. 1 to 4.

One of the simplest and most common plans is that shown in Fig. 1. This is adapted to locations having a long heating season, where fuel is comparatively cheap; and to plants using low-pressure steam for process work or water heating during the summer. With this arrangement, more or less exhaust will be wasted in the summer, but not enough to warrant the installation of more expensive and efficient equipment.

In Fig. 2 the plant is arranged for operating the engine or turbine condensing during the summer season, thus reducing the cost of fuel. Live steam is used for water heating and process work at a reduced pressure. A longer non-heating season and higher cost of fuel are important factors in this arrangement. During the winter the plant is operated non-condensing and the exhaust utilized for heating purposes. When a considerable quantity of steam is required for process work during the summer a small non-condensing turbine may be substituted for the pressure-reducing valve in Fig. 3. The main prime mover may be operated either condensing or non-condensing as conditions indicate at different seasons of the year.

Sometimes a combination of non-condensing engine and low-pressure turbine operate to good advantage on

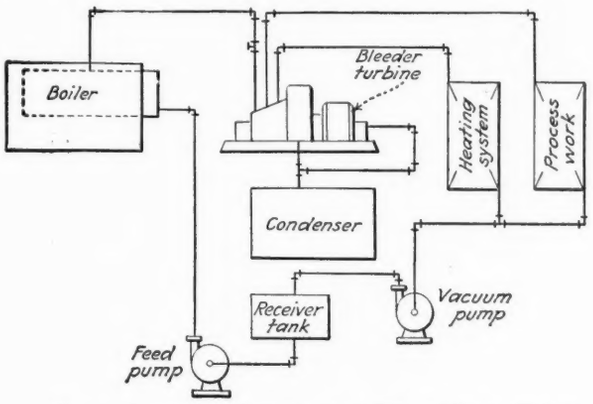


Fig. 4—Power and heating plant using bleeder turbine

an annual basis, steam being drawn from the receiver for heating and process work, as indicated in Fig. 3.

For large plants requiring steam at different pressures, the bleeder turbine gives a high all-around efficiency, as only enough steam at the different lower pressures is extracted to do the work. This action is entirely automatic, and the machine adapts itself to all seasons of the year. This arrangement is shown diagrammatically in Fig. 4.

While there are a number of other schemes adaptable to special conditions, those shown are the most common and are more or less flexible in their application to varying requirements.

The Fundamentals of Wetting Down Coal

By R. K. Long

WETTING DOWN coal is of importance wherever coal is used, with the exception of anthracite coal, where wetting down is not efficacious. Where wetting down is practiced, it seems to be the policy to allow every fireman to use his own discretion as to how much water is used, how it is applied, and when it is applied. The following information may be of value and suggests a way by which every plant can check up on how water is being used for wetting down and to what extent this experience may be applied to minimize the amount of water and so minimize the loss of heat due to its evaporation and decomposition.

1. Moisture is objectionable, because it requires heat to evaporate it and decompose it. Therefore, wherever wetting down is done the minimum amount of water that suffices should be used.

2. The effect of wetting down is purely physical and mechanical and the gains are due to the fact that the advantages in the way of draft, spillage and more uniform fuel beds are usually greater than the objections due to the addition of moisture.

3. Except for anthracite, and Eastern coals, practically all coals burn better due to a certain amount of wetting down or tempering. Wetting down is usually indicated with screenings, especially with the finer sizes of coal, slack coal, coke breeze, and whether used on hand-fired grates, chain grates, or overfeed stokers. With underfeed stokers, wetting down or tempering does not seem to have any advantage and in some instances has disadvantages.

4. Coal should be moistened, never soaked, since moist coal requires less draft to burn it than either wet or dry coals.

5. While the amount of water to be added to the coal will necessarily depend upon the size, quality, characteristic and condition of the coal, experience indicates that approximately 3 per cent of water by weight is usually the most desirable.

6. It should be remembered that coal loses about 0.3 per cent evaporative value with 3 per cent moisture.

Hot Water Often Better Than Cold for Wetting Down

Time is an element in the effectiveness of wetting down coal. Therefore, wet down in ample time before firing. Hot water is more effective than cold, since it has greater affinity for the coal. If coal is to be fired almost immediately after watering, better results will be obtained by using hot water. The use of heated water should be carefully analyzed, however, due to the loss of heat units that it will occasion. The use of exhaust steam, especially when using coals not readily inflammable during peak load, and where a surplus of hot water is available, deserves consideration under certain conditions.

Where coal is wetted down on the floor some time before firing, cold water suffices. Where the coal is wetted down in the stoker hopper it is preferable to use warm or hot water. Wet coal is very corrosive, and hot water is more corrosive when mixed with coal than cold water.

. . . RIGHT OUT OF THE PLANT . . .

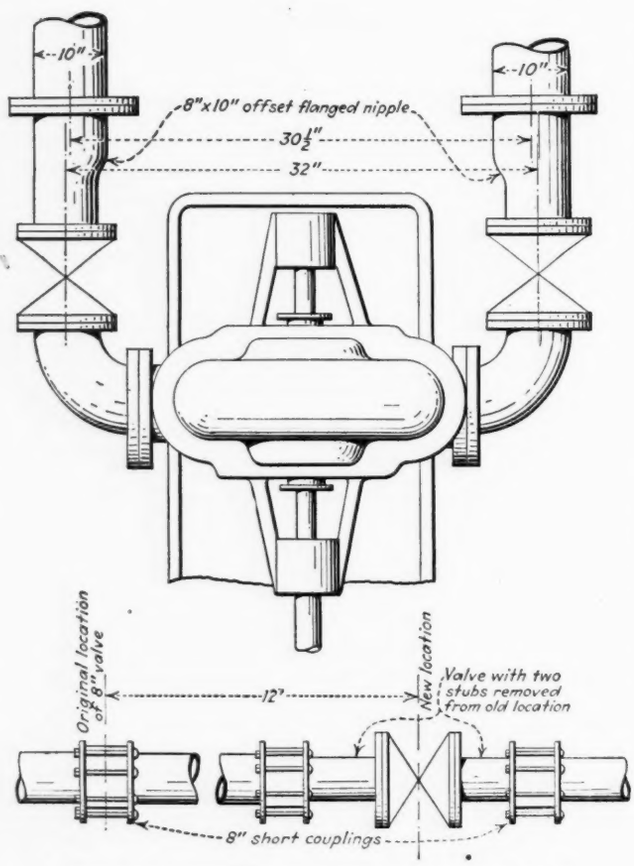
How Pump and Valve Were Installed With a Minimum of Shutdown

DURING extensions to a compressor plant it was necessary to change one of the water pumps for a larger size. This work had to be done with a minimum of shutdown; also, owing to the presence of gas, welding or cutting with a torch was prohibited. The face-to-face dimension of the existing pump was found to be 30½ in., and the face-to-face of the new one 32 inches.

There being a short run on both the suction and discharge lines into the headers, there was no possibility of springing them enough to make up the difference of ¾ in. on each side. Fortunately, the suction and discharge, both 8 in., were increased to 10 in. with a concentric swedged nipple.

To get the new pump in, two more nipples were made eccentric, that is, ¾ in. off center, so that one side was straight while the other side was off the necessary ¾ inch.

The new pump was somewhat lower than the old one, so it was easy enough to shim it up to suit the height of the existing fittings. The pump was shut down, fittings were removed, and the pump was hauled out. One gang of men sawed off the existing foundation bolts and leaded new ones in. The other gang built up the ells, valves, and offset nipples on the new pump and quickly moved it into place. The offset nipples, with their 10 in. companion flanges, lined up perfectly with the existing flanges on the lines. Bolts were put in, the motor was hooked up, and all was ready.



How pipe connections were made to pump and valve

The job of removing and putting in the new pump and motor was done in 2½ hr. This was the time that the pump was actually off the line. The starter, nipples, etc., were all made up before shutting down, the only time lost being during the actual changeover.

Further down the line an 8-in. valve had to be moved. This was also done without the use of a torch by cutting the line with a hacksaw, a section of pipe being left on each side of the valve.

Another cut was made in the new location, some 12 ft. away. A Dayton coupling was then put over the end of the pipe, and the other piece was slipped along 12 ft. and to the other end of it. For installing the valve two couplings were slipped over the ends of the pipes. Then the valve, with the two stubs of pipe attached, was lowered into place and the couplings were slipped over the joint and tightened up. This was done at the same time the pump was being changed.

Long Beach, Calif. M. C. COCKSHOTT.

Taking Care of Equipment During Erection

MODERN power plant equipment is usually purchased under certain specified performance guarantees. Such guarantees appear to be warranted as bona fide on the manufacturers' test bed or shop trials, but another story is presented when the actual installation is complete. The following from recent exeperience will illustrate how necessary it is that equipment supervision be as exacting, prior to placing in operation, as when operating.

To take care of additional radiation and to replace an obsolete heating plant consisting of three horizontal return tubular boilers and auxiliaries, a complete new boiler plant of three 1,830-sq.ft. water-tube boilers and pumps was ordered by a certain company.

The erection took place during a severe winter. In unloading a section of tubes into the boiler house a chain

sling slipped, buckling a number of tubes in the center, which apparently was not noticed. The boiler setting froze as it was being erected, with the result that when a load of less than 100 per cent was being carried during the trial run bad cracks showed up in the side walls. The chain-grate ran backward due to incorrect setting on first trial.

All pumps and large valves were allowed to lie around the boiler house floor during erection, with consequent damage and bending of the spindles and stems. The tandem blowdown valve joints blew out while the boilers were being filled with water prior to lighting up. Safety valves did not lift at their tagged pressure; the steam pressure gages did not correspond—one even had the pointer behind the zero stop. Automatic soot blowers were installed with their condensate drains so arranged that the operator was in serious danger of scalding. House and vacuum pumps spindles and bearings were covered with splashes of concrete.

Manufacturers evidently should demand that the utmost care be taken of their respective specialties prior to installation as a safeguard against the fineness of their products being wrecked by a few moments' careless handling by erectors.

E. O. WILSON.

Montreal, Quebec.

Eliminating Ammonia Compressor Knocks

ALMOST every engineer in charge of a refrigerating plant has at some time had the problem of locating a knock in a horizontal ammonia compressor. Usually the knock appears to be in the crosshead. Not infrequently after checking all of the bearings the knock still persists.

It has been my experience that in a number of cases where the knock appeared to be in the crosshead the source of the trouble was a loose piston. In that case the piston may be examined through the valve ports, with the valves on the head end removed. A usual method of determining if the piston is loose is to hold a thumb and finger on the nut and the piston, while a helper gives the piston a solid jar by means of a heavy bar through the other valve port. A slight movement will be felt if the piston is loose. To tighten this, the head must be removed.

The piston may be tightened in one of two ways. By adding the required amount of steel shims to allow the pin holes in the rod and nut to line up. If this does not make a permanent repair, it is because the shims have compressed or squeezed out and the nut is loose again. This may be due to the piston's having been loose for a long time. Then there is nothing to do but to remove the nut, clear out the old shims, replace the nut and turn it up as tight as possible. It is a good plan in some cases to heat the rod slightly with a torch. Good judgment must be used, however, in doing that. When the nut has been set up tight a new hole will have to be bored through the nut and rod for the pin.

Different makes of compressors have different methods of holding the nut, which will be taken care of according to the best judgment of the repair man.

EARL W. HALL, *Mechanical Superintendent,*
Saskatchewan Co-operative Creameries, Ltd.
Regina, Saskatchewan.

Value of the Central-Station Training

A YOUNG ENGINEER who goes to the central station job straight from school should quickly make up his mind whether he is to achieve a central-station career or whether his work is to be merely a stepping-stone to something else. If he is looking for a steady job where he can lean more and more upon his employer, the large-central station company presents these opportunities. The central station organizations of today are allowed to earn a fixed rate upon their investment. They are relatively free from competition. Because of the interchange of ideas within the industry, each central station knows what other plants are doing, what equipment is available and what is to be expected of it. Because fuel is such a large item of expense in the manufacture of power, considerable attention is given to improving efficiency. At the same time, the central stations almost invariably view fuel economy on the basis of pounds of coal per kilowatt-hour. This immediately narrows the viewpoint of the central-station operating engineer contrasted with that of the engineer in charge of an industrial plant.

The young engineer entering the employ of a large central-station company, and the larger the company the greater the truth of this, must guard against becoming a cog in the wheel. Men are promoted largely according to their length of service; and the restless man, seeking to crowd as much experience as possible into each day, will find himself engulfed by rules and regulations of many years' standing. Men who have been with the company 20 or 30 or even 40 years do not want to change. They resent intrusion of a youngster's suggestions. The very mass of the large central-station company necessarily gives it inertia. If the young engineer is making his life work central-station engineering, then he will have to be content to bide his time, tune in with the organization and travel the same speed as the rest of them.

He will find that his work will necessarily be specialized. If he starts in on instruments he will probably spend much of his life with instruments. If he is in the boiler room or on the turbine floor, he will have to specialize upon these matters and probably will not travel far from them. While he will assist on many tests and investigations, he will find out that the manufacturers are making the discoveries and improvements, while the central-station companies verify them and enable them to be put to work.

The young engineer, if he ultimately gets outside, where his task is to analyze industrial plants with a view to taking them over to central-station service, may find that his viewpoint is one-sided. He will make tests and analyze them, always endeavoring to prove that central-station service is the sound solution, and that for the isolated plant to continue to operate is an economic waste. At the same time, his conscientiousness—and the better and more true engineer he is, the more sensitive will his conscience be—will tell him that ball bearings, group or individual drive, change of prime mover, replacement of 30- or 40-year old second-hand equipment by modern reciprocating engines, steam engine and Diesel or steam turbine, improvements in the boiler room that may reduce the fuel consumption anywhere up to 25 per cent, in many cases from the basis of a real sound engineering

solution. A central station is much like the army. Everyone must keep in step. The young engineer will find within a year or two that the path of least resistance is to not make too much fuss, not show too much initiative or inquisitiveness, nor to try to work his way up to the top too quickly. He must bide his time and take his turn. He will learn his "bit" and not know much about other aspects of the problems, the commercial side, the financial side, the purchasing of supplies, etc. After he has held his job for 10 or possibly 15 years he will find that he is something like the machines he operates. If he decides to quit his job and go out into the world and stand on his own feet, he will find himself badly handicapped. He will miss the organization behind him, the committees to consult, recommend, and command. The longer he stays with the one company, the more difficult it will be for him to go out and "go it alone." During this time he will undoubtedly have purchased a considerable quantity of his company's stock and have a real personal interest in the organization.

Two or three years with a central-station company, or better still, with several different companies in different departments, will give the young engineer good insight into the modus operandi of a company and its organization. With this as a background, he should then go out and put his experience to work. When an engineer with a large industrial plant he will find a bigger opening for his initiative. He must be more ingenious. He will have to get along with what he has. It will be more difficult to obtain capital for improvements and extensions. He will find that he is dealing with over-all economy, rather than pounds of coal per kilowatt-hour. He may find opportunities to make his electric power as a byproduct, while using the live or exhaust steam for manufacturing processes. If he is in a large foundry using steam hammers, he may find that he can generate electric power with steam turbines from the used steam. There are a hundred-and-one things which he can do if he has the vision, the confidence in himself, and the true qualities of the engineer that he could not do with the central-station company.

If he gets the right sort of job and makes a good showing, at the end of three or four years another job will come to him, better, more responsible, that offers him a still wider field for his ability. From the start he will be standing on his own feet, depending upon his own initiative and ability. When "on his own" he may have to endure more ups and downs. He may travel from one part of the country to another, so seeing more of life and the country. He may miss the group insurance and the old-age pension, but he will add to his experience, he will learn to assert himself and develop that greatest of all gifts, self-confidence.

The majority of the youngsters joining a central-station company can hardly hope to rise to the top—because there are not so many men needed at the top. Therefore, in making his choice, the young engineer should try to visualize his goal. A central-station training affords a magnificent background for any man straight from school. Some settle down early and want comfort, stability, and minimum exertion with safety. Others are tireless, energetic, and enjoy life with its hardships, uncertainties, and achievements. To take a job with a central station is always safe and always worth while. The next decision is whether it is to be a stepping stone or a career.

K. RANKIN.

Chicago, Ill.

Method of Checking Amount of Air Delivered by Air Compressors

RECENTLY I had occasion to arrive at some practical means of determining whether air compressors, which we regularly rent to contractors, were delivering their rated capacity after being overhauled in our shop and before leaving for the job. The following is an outline of the method used:

Take, for an example, a 60-cu.ft. and a 120-cu.ft. portable machine. The 60-cu.ft. machine carries a 4.88-cu.ft. capacity air tank. Arbitrarily choosing 75 lb. tank pressure to pump up to, we can assume that when the gage shows 75 lb. the compressor has delivered into the tank $4.88 \times 6.1 = 29.8$ cu.ft (6.1 being the volumetric ratio at 75 lb. pressure and atmospheric pressure respectively), which is the same as to say 4.88 cu.ft. of air at 75 lb. equals 29.8 cu.ft. air at 14.1, or atmospheric pressure. Therefore, a 60-cu.ft. machine, if working properly, should pump up to 75 lb. pressure in $\frac{29.8}{60} \times 60 = 29.8$ sec., and since the 120 ft. machine carries the same size air tank it should pump up to 75 pounds in $\frac{29.8}{120} \times 60 = 14.9$ sec.

This method has been found sufficiently accurate for check-up work, and is one that can be used by the operator in the field as well as by the mechanic in the shop.

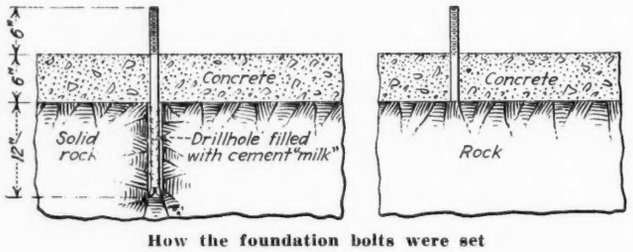
R. H. PARRISH, *Sales Engineer,*
Alamo Iron Works.

San Antonio, Texas.

Securing Engines on a Rock Bed

NOT INFREQUENTLY too little care is taken to supply the proper foundation bolts or have them properly anchored when installing engines and other reciprocating machinery.

In one case I encountered at a mine an engine was loose on the foundation and had to be secured with braces until it could be removed and the bolts reset. It was later found that the bolts were placed in a thin concrete slab placed on rock about as shown at the right in the illustration.



How the foundation bolts were set

When resetting the engine larger holes were drilled through the concrete, and extended down into the bed rock about 12 in. The lower ends of the new bolts were split and ragged, as shown on the left. This held the engine securely, and no more trouble was encountered.

Scranton, Pa.

F. NEUMAN.

From Among Readers' Problems

Conducted by
L. H. MORRISON

STEAM CONSUMPTION OF CONDENSING PUMP—*We have a duplex steam pump operating against atmospheric exhaust. To what could we expect to reduce the steam consumption if the exhaust were connected to a condenser?* M.R.

A duplex steam pump, if without a flywheel, uses steam for the full stroke without expansion. The work done in foot-pounds is, then, $A\ S\ (P_1 - P_2)$, when

A = Piston area, in sq.in.
S = Piston stroke, in ft.
P_1 = Pressure in the steam chest, lb. per sq.in.
P_2 = Exhaust pressure, lb. per sq.in.

As the area and stroke are constant it can be said that the work $= C\ (P_1 - P_2)$, where C is a constant.

If the work is to be the same, obviously $P_1 - P_2$ must remain unchanged, so that if, when condensing, P_2 is reduced to, say, 4.7 lb. abs., then P_1 must be reduced by $(14.7 - 4.7) = 10$ lb., since the back pressure has been reduced by this amount.

The difference in steam consumption for an equal number of strokes per minute and an equal water resistance is the difference in the specific volume of steam at the original pressure P_1 and the new initial pressure P_1.

Assume that when non-condensing $P_1 = 135$ lb. gage, or 150 lb. abs., the specific volume at this pressure is 3.012 cu.ft. per pound. If the pump is to run condensing with an exhaust pressure of 4.7 lb. absolute, a drop of 10 lb., then the new initial pressure must be 150 — 10 = 140 lb. abs. The specific volume would be 3.219 cu.ft. The decrease in steam consumption would probably be

$$\frac{3.219 - 3.012}{3.012} = 6.2 \text{ per cent.}$$

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REMOVING RUSTED TAP BOLTS AND NUTS—*How can tap bolts and nuts that have become rusted be removed from a waterwheel case?* C.P.

To loosen tight or rusted tap bolts or set-screws, strike the heads of the screws a number of sharp blows with a medium-sized hand hammer, and to loosen nuts strike the end of the bolts covered by a short tool, countersunk to prevent the screw threads from becoming mashed.

HEAT GIVEN OFF BY LAMPS IN REFRIGERATING ROOMS—*In laying out a system of piping for a cold-storage room, the heat developed by the electric lights in this room must be taken care of in the square feet of cooling surface provided. In talking this over with different engineers there seems to be a great difference of opinion as to the amount of heat given off by lamps. Some allow values for the heat units given off by a 100-watt incandescent lamp as high as 1,650 B.t.u. per hour. What is the method of calculating the B.t.u. given off by different sizes of lamps?* D.L.F.

Undoubtedly, the confusion of opinion on the question lies in the fact that part of the energy supplied to the lamps is given off in the form of light and part in the form of heat, and the question is, what becomes of the energy converted into light?

A refrigeration room has opaque, non-heat-conducting walls. Therefore, the light energy emitted from the lamp would ultimately strike the walls of the room and be converted into heat. The total effect of the lamps upon the cooling system would, therefore, be exactly the amount of energy that is put into them. Mazda B (vacuum) and Mazda C (gas-filled) lamps of equal wattage give off different proportions of light and heat. In a refrigeration room, however, their ultimate effect upon the cooling system would be the same. The relation between the watt and B.t.u.'s per hour is as follows:

One watt equals 3.412 B.t.u. per hour. From this relation we can compute the following table:

Wattage of Lamps	B.t.u. per Hour in Refrigeration Room	Wattage of Lamps	B.t.u. per Hour in Refrigeration Room
7½	25 6	50	170.6
15	51.2	60	204.8
25	85.3	75	256.0
40	136.5	100	341.1

From the foregoing it is evident that the figure 1,650 B.t.u. for a 100-watt lamp is very much in error, since it is equal to about the value for a 500-watt lamp, which is 3.4136 × 500 = 1,707 B.t.u.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

I AM operating a 1,250-kva. waterwheel generator and a 1,000-kva. steam turbine-generator in parallel and they are synchronized with a synchroscope. If the synchroscope were out of order, could the incoming machine, without excitation, be brought up to synchronous speed and connected to the busbars? D.O.J.

IT IS feasible for the incoming generator to be paralleled as outlined in the question. This scheme will probably be most successful when the waterwheel generator is the incoming machine, since its impedance is probably much greater than that of the turbine. At the instant that the circuit breaker is closed the synchronous speeds of the two generators should be equal and steady. It is important that both governors be free from hunting.

An objectionable voltage disturbance may result from this zero-field method of paralleling, especially if the running machine is fully loaded at low power factor. The voltage may drop low enough to trip low-voltage release devices, thus causing an interruption. The voltage regulator for the running generator should be in operation. If a serious distrubance develops while the generators are pulling into step the incoming generator should be promptly disconnected.

Before deciding to follow this method of paralleling the generators the following points should be considered:

1. The rating of the incoming generator should preferably be a small per-

centage of the rating of the generators that are in operation. In this case the generators have approximately equal ratings.

2. Synchroscopes are reliable devices that give very little trouble, especially if of the type that can be left in circuit continuously. So true is this that in many plants a spare synchroscope is not provided.

3. Synchronizing lamps generally are, and should always be, installed, and the synchroscope should be checked with these lamps each time it is used. It would be better to use synchronizing lamps if the synchroscope failed. The only occasion that would justify the zero-field method is when a generator must be paralleled without delay, such as when the frequency is decreasing due to a sustained overload. (Few are the stations in which generators are ever paralleled by the zero-field method.)

4. The synchroscope is actually the most important electrical instrument in the power plant. Such an instrument can be purchased for about $75, and an additional one should be installed with its own synchronizing lamps. But the lamps now doubtless in use should suffice for emergency synchronizing. It must be remembered that before the invention of the synchroscope, synchronizing was well done under trying conditions by using synchronizing lamps. If the generators were considerably larger a spare synchroscope should certainly be installed.

A problem of this nature should be referred to the generator manufacturers, since they generally possess the data necessary to give an exact solution—for machine characteristics vary.

ARTHUR MAY.

Bakersfield, Calif.

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IN PARALLELING alternators, it is a well known fact that three functions must be satisfied: First, the voltage of each alternator must be identical; secondly, the voltages of all machines must be in phase; and, thirdly, the frequencies of all machines must be the same. In order to have the same frequency, the machines must operate at normal speed, while in order to have the some voltage each machine must have field and power excitation. If an alternator satisfying the frequency function, but without excitation, were paralleled with another, it would be the same, in principle, as throwing a large induction motor, operating at full speed, across the line. If the operating alternator were carrying around full load, it would receive a severe bump. While excitation was being applied to the incoming machine, the voltages would fluctuate, causing load distrubances, and in all probability trip out the operating machine, and probably both. The greatest disturbance would take place if the larger of the two machines was the incoming one.

It is not necessary to take any such chance in operating alternators by this method in the event of the synchroscope's going out of commission, since alternators may be synchronized by lamps. If the voltage at the bus is low, lamps alone are required, the number corresponding to twice the voltage of one machine divided by the voltage of the lamps. If the bus voltage is high, a small potential transformer is used. This is by no means expensive, since a rating of 100 watts for the transformer is adequate. The machines are paralleled in the same manner as when a synchroscope is used, the time to parallel being at, or as near as possible to, the middle of the longest dark period on the dial.

Another method which has been often used is to start up both machines tied together and excited. When both machines are operating at full speed, the excitation of both is adjusted before applying load. A spare synchroscope is the best insurance if trouble is expected.

H. E. STAFFORD,
Electrical Engineer,
Provincial Paper Company.
Port Arthur, Ontario

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SOME YEARS AGO, while operating in a hydro-electric plant, the same question occurred to me. I was advised by the electrical engineer in charge that it could be done in emergency, but I could not get permission to test it out. However, I have met men who have done it successfully. There appears to be no difficulty if the incoming machine is about up to speed, and the capacity of the incoming machine is less than those of the line.

Rushmore and Lof, in their "Hydro-Electric Power Plants," state: "In cases of serious emergency where there have already been interruptions to service or serious fluctuations of voltage, or where the hydro-electric plant has separated from the steam plant, the operator is instructed to parallel without the use of the synchronoscope, in order to save time. In this case he opens the field switch of the incoming generator while closing the oil switch, and immedaitely closes the field switch afterward."

In the case cited, a 5 to per cent fluctuation of voltage is be obtained on an incoming machine of 10,000 kw., which is 20 per cent less than the capacity already on the busbars. High-reactance machines are most suitable for this operation. It might be well to consult the makers before experimenting.

T. H. DICKSON.

Moncton, New Brunswick.

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PROCEDURE outlined for synchronizing a steam turbine-generator and waterwheel generator without a synchronism indicator will be found fairly satisfactory if one additional precaution is observed. The excitation of the incoming generator must be applied slowly, so that synchronizing will occur without objectionable swinging. The line disturbances in this case will be greater than they would be if two steam sets or two waterwheel sets were being synchronized, because of the difference in sensitivity of governors of steam turbine and waterwheel. This difference is due to the inertia of the water column behind the waterwheel.

Scotia, N. Y. E. E. KIMBERLY.

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I AM NOT enthusiastic about connecting the generator without excitation to the busbars when up to the synchronizing speed of the generator already in service. However, if the two generators were working in parallel and one of them should lose its excitation, due to field switch opening, it would be safe to immediately close the field switch. The generator would then pull into step with the one already in service. There would be some disturbance on the system, while the field switch was open, depending on the load on the generator. The larger the load, the greater the disturbance.

In an emergency, a safer way of putting the two machines on the system without synchronizing is to shut down both generators, close the switches connecting the generators to busbars, close both field switches, and adjust each generator's field current to a value that will give normal system voltage at synchronous speed. Then start either of the generators, when it commences to revolve, and the other generator also starts. If desired, the generators may be brought up to running speed in this manner before opening the throttle valve of the second machine. Or, as soon as both generators begin to revolve, the throttles of both may be opened at the same time and the generators brought up to speed in the usual way. Once started in this way they will keep in step the same as if synchronized after being brought up to speed. This was the method of starting we used for several years in one plant to operate some of the generators as synchronous condensers to boost the voltage on the system.

F. E. BESCOBY.

Vancouver, British Columbia.

A Question for Our Readers

WHAT is the best way to restore the insulation of armature winding and field coils that have become oil soaked? Can gasoline be used satisfactorily for cleaning, and what is the best way of applying the cleaning fluid? S.W.A.

Suitable answers from readers will be paid for and published in the Sept. 23 number

STRAIGHTENING A 15-TON SHAFT WITHOUT SHOP FACILITIES*

By G. E. DECKER and C. G. HECKMAN
Southern California Edison Company, Los Angeles, Calif.

Field methods and equipment to reduce the curvature in a vertical generator shaft 35 ft. long and over 21 in. in diameter—straightening was done by heating with the rotor in place on the shaft

AT THE Big Creek No. 3 hydroelectric plant of the Southern California Edison Company, a vertical-shaft 28,000-kva. unit vibrated so badly that it had to be taken out of service. The cause of the trouble was found to be a bent shaft. It was not thought practical to remove the rotor from the shaft. The core is made of 2½-in. plates shrunk on the shaft. It was therefore decided to do the straightening by heating the shaft with the rotor core in place. The shaft is 35 ft. long, 21⅜ in. diameter in the rotor and tapered by steps to 18 in. in diameter at one end and 10 in. in diameter at the other.

When the unit was dismantled and the rotor placed in a horizontal position and rotated in temporary bearings it was found that there was a 0.021-in. bend in the shaft approximately at its middle point. This deflection represented the deviation as measured from a straight line connecting the centers of each end of the shaft.

Measurements here quoted, however, are those obtained by rotating the shaft in the temporary bearings and therefore indicate the total movement occurring at the place of measurement during one revolution. By this method the gage at the upper end of the shaft (the left-hand end in Fig. 1) gave a reading of 0.027 in. and the gage at the lower end a reading of 0.050 in. At the same time a gage reading obtained at the center of the rotor showed a deflection of 0.007 in. in the opposite direction. Plotting these data to obtain a graphical representation resulted in curve *A*.

Temporary equipment was set up on the power house floor and, after successive applications of heat, the shaft was brought to within 0.0015 in. of a straight line. This minute deflection in a 35-ft. shaft was considered negligible and the unit was put back in service.

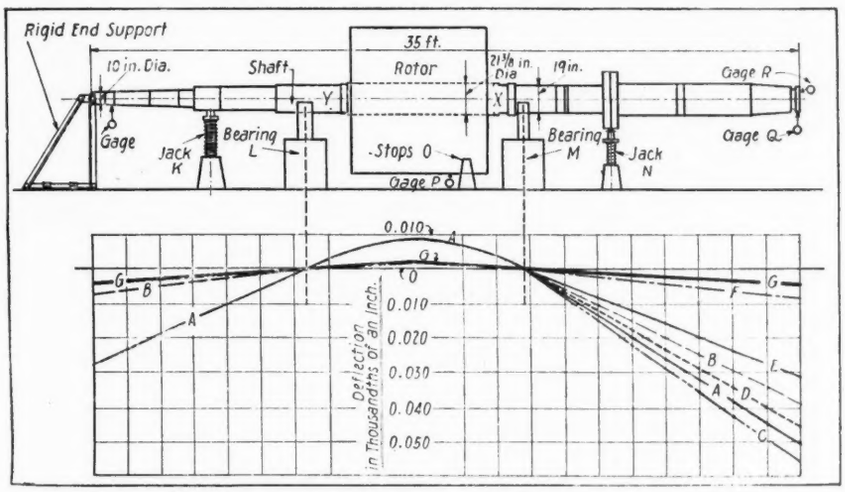


Fig. 1—Deflection curves and general arrangement of the equipment for straightening the shaft

Just how the bend occurred in the shaft is not definitely known, but it is known that the car on which the shaft and rotor came from the factory was wrecked in transit. It is quite possible that this car rode the ties, or may have had even rougher treatment. There had always been considerable vibration in the machine and after several years of service it became serious in spite of some major changes made in the waterwheel equipment and some repairs made to field coils. Load and water conditions were such that it was necessary to continue the unit in service for several months after it would otherwise have been shut down for overhauling. During this time several attempts were made to reduce the vibration by the usual counterbalancing methods, but without much success.

Figs. 2 and 3 show the repair set-up, with the rotor in place on the temporary bearings. These bearings were mounted on concrete blocks poured on the power house floor. To obtain accurate and consistent readings a firm foundation was required, particularly as the rotor assembly weighed 120 tons.

A driving belt (which may be seen around the rotor, Fig. 2) also passes around the drum of a variable-speed, motor-driven, portable hoist used to rotate the shaft when the surface gage readings were being taken. Eight Starrett dial-type micrometer gages

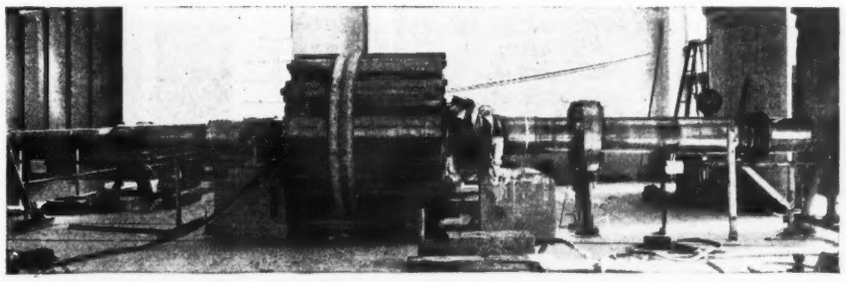


Fig. 2—View of the rotor corresponding to the diagram, Fig. 1

*From *Electrical West*.

were used in various positions, five of which are shown at *G*, Fig. 3. These were mounted on rigid angle-iron frames, conveniently placed and bolted to the floor.

To confine the heat to the desired shaft area a rough box of asbestos sheets was formed around the shaft at the bend. This box was left open at each side of the shaft to permit the flame of a large kerosene pressure burner to be applied directly to the shaft on each side. With this arrangement there was complete control of the heat. By varying the flame of either burner, and by raising or lowering the flames, the possible distortion of the shaft due to heat strains was kept under full control.

Heat was applied first at *Y* on the shaft, and resulted in a correction, as shown by curve *B*, Fig. 1. All subsequent heats were made at *X*.

The method used was based upon the known fact that a horizontal shaft will almost invariably receive a permanent bend if allowed to come to rest and cool in a bearing that has become sufficiently hot to melt the babbitt. With this in mind the situation was reversed for the purposes of this repair job. The shaft was placed in a horizontal position with the high spot of the bend up between two rigid supports. Then heat was applied at the point where it was desired to bend the shaft. The maximum temperature used was that sufficient to melt babbitt or a little more, and ranged from 600 to 800 deg. F.

In all, some twelve successive heats were made. But some of them were lost or had negative results because of a lack of definite knowledge of many of the variable factors to be contended with, or how best to control or counteract these undesirable effects. As these unknown factors were discovered they were analyzed and compensated for; but they were most aggravating when met with.

It is believed, however, that another job of this kind would be comparatively simple and that it would be possible to show a definite improvement for each successive heat.

A typical operation for a single heat at point *X* will suffice as an explanatory guide, because all heats were made on the same principle. The shaft was rotated at about 15 r.p.m. and gage readings were taken on the under side of the shaft. The position of the high spot and the amount of its deflection in thousandths of an inch were marked on the shaft. Then the shaft was brought to rest in such a position that the bow of deflection was up at the middle and down at the ends. With jack *K* removed, jack *N* was raised until the shaft had a clearance of about a quarter of an inch in bearing *M*. With the entire weight thus carried by bearing *L* and jack *N*, bearing *L* acted as a fulcrum about which the mass of the rotor would tend to rotate if the shaft were softened at *X*.

Stop-blocks *O* were put in place under each side of the rotor, and jack *N* was lowered to allow the entire weight to rest on bearing *L* and stop-blocks *O*. With the shaft in this position all gages were set to zero reading. Then jack *N* was operated to raise the shaft a definite predetermined amount. As indicated on the gage under the rotor at *P*, the amount raised ranged from 0.006 in. to 0.012 in., and the gage under the end of the shaft at *Q* read from 0.090 in. to 0.110 in. Particular care was taken to see that the side gages still read zero after the shaft was raised.

Heat then was applied at *X* and controlled as necessary to hold all gages at the initial readings at which they were set. Heating was continued from 60 to 90 min. When a temperature of about 700 deg. F. was obtained a very noticeable movement of the shaft took place and the heat application was immediately stopped. It was allowed to cool until the next day, when stop-blocks *O* were removed and the shaft was lowered into bearing *M*. Then by rotating the shaft the amount of correction was noted from gage indications at the various points. On the basis of results obtained, plans for the next heat application were made and the process was repeated.

The various curves, *A*, *B*, *C*, *D*, *E*, *F*, and *G*, in the order named, are the results of the successive heats. Curve *C* shows a negative result as compared with curve *B*. This occurred because sufficient attention was not given to watching and preventing heat-stress deflection while focusing attention upon the desired corrective bending motion. Thus, while a correction was made in the desired plane, another deflection occurred in another plane. The technique, however, was improved so that the last four curves, *D*, *E*, *F*, and *G*, were as expected and the movement of the shaft was under perfect control. It is of some interest that the successive readings obtained from gage *R* at the end of the shaft, an indication of its longitudinal expansion, also gave an accurate indication of comparative temperatures. This gage really indicated the attainment of desired internal temperatures more accurately than the thermometer mounted against the shaft immediately adjacent to the point of heat application.

It is believed that almost any shaft could be straightened by this method at a much lower temperature than has been generally supposed to be necessary. It is also believed that the necessity for turning down with a lathe tool may be obviated in practically all cases. The cost is only a small fraction of any other common method of doing the work. For several months the repaired unit has been back in service and gives every evidence of continued satisfactory and quiet operation.

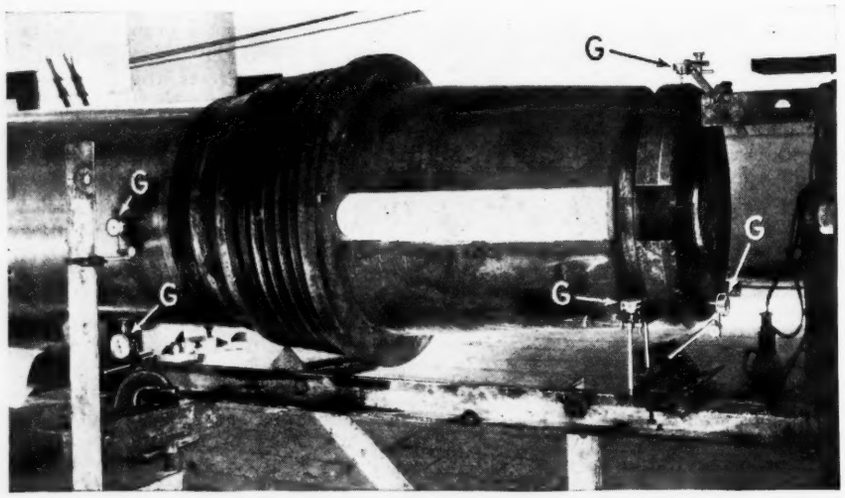


Fig. 3—*G* shows 5 of the 8 micrometer gages used to check the shaft's deflection

Industrial Power Development in Central America Shows Gain

THE REPUBLICS of Central America and the British Colony of Belize —an area of 215,276 square miles, with a population estimated in 1928 at 6,466,000—have no developed coal, petroleum, or natural gas resources, and in 1926 but 38,400 hp. was developed of its total estimated and relatively high water-power resources of 4,800,000 hp.

The greater part of the power has been generated from imported fuels, formerly coal but now fuel oil. Total coal imports in 1913, when the use of power from oil fuel and water power were of little moment, amounted to approximately 70,000 tons.

Recent data indicate that the coal consumption of the region has declined to about 17,000 tons a year, that water power approximating the equivalent of 100,000 tons of coal a year has been developed, and that oil fuel in a recent year was the equivalent of about 360,000 tons of coal. While available data for the periods do not permit the segregation of coal and oil fuel used, it seems clear that power available for industrial use is much greater than in 1913.—*Commerce Reports.*

Power Production in the Steel Industry

. . . A World Power Conference Paper

By C. W. E. CLARKE

United Engineers & Constructors, Philadelphia

IN THE early days steam pressures were low, and the efficiency of heat utilization in the steam cycle was consequently poor. Motor drive for rolling mills was unknown, the first installation of this kind as far as can be found from available records, having been made in 1905. Consequently, all mill drives were by reciprocating engines and with the then prevailing pressures the thermal efficiency was poor. One result of the use of engine drives was the construction of a multiplicity of boiler plants located conveniently to the several points where steam was used in large quantities.

The growth of the steel industry in the past thirty years has been tremendous and the power facilities have had to be expanded to meet the rapidly growing needs. The natural course was to increase capacities along the general lines of the original installations. As the magnitude of the power consumption grew the advantages in current methods became of greater moment but by then the installations of the older order had reached such proportions that a change to new methods appeared difficult. As a result a large proportion of the steel plants today contain equipment of efficiency so low that its continued operation places an unnecessary and almost prohibitive financial burden on the owners.

Developments in methods of steel manufacture are daily rendering the old mills obsolete and requiring the installation of new types of equipment. These new mills are almost universally being installed with motor drive.

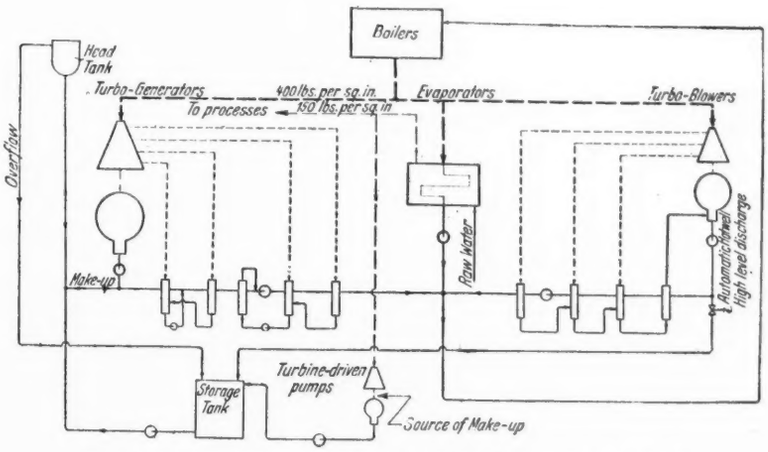
In this period of reconstruction and rehabilitation the steel men are faced with the question as to how the development of their power and steam systems shall be carried out. Among the factors which must be given consideration are:

(*a*) Power and steam loads including hour to hour variations in both.

(*b*) Availability of water for condensers and boilers.

(*c*) Waste fuels (blast furnace gas, coke oven gas, and waste heat from open hearths or other furnaces) and their availability as related to steam and power loads.

(*d*) The probable future development of the mill in the light of possible expansion on the property available, increase in diversity of products and economic value of the location as related to markets and shipping cost and proximity to raw materials.



Heat-flow diagram of recent plant employing regenerative cycle

In a plant containing blast furnaces a considerable part of the top gas is available for boilers. The quantity of steam that can be generated per ton of pig iron depends upon the amount of coke charged per unit of pig iron. The amount of coke charged depends, in turn, upon the quality of coke, the character of the ore smelted, the use for which the pig iron is being made and the excellence of furnace operation. Under normal conditions coke rates prevailing in American practice vary from a minimum of about 1,500 lb. per ton of pig iron with a high-grade Lake Superior Hematite ore to a maximum of perhaps 3,000 lb. per ton with a low-grade Clinton red Hematite. Part of the gas must be used for heating the blast but with well designed stove and burner installations this should not exceed 25 per cent and may be as low as 20 per cent.

In some plants, gas is used in internal-combustion engines to drive the blowers. However, these engines require very clean gas which is difficult to secure and their first cost is great. It seems to be the opinion of most operators that steam driven turbo-blowers are better from the over-all economic standpoint. With steam driven turbo-blowers and a steam system operating at a pressure in the neighborhood of 450 lb. per sq.in. the steam available after providing for heating the blast and operating the turbo-blowers varies between about 4,500 lb. per ton of pig iron with a coke rate of 1,500 lb. and 10,800 with a coke rate of 3,000 lb. Some steam is required for general uses about the plant, the amount varying in different plants. In a mill which does not include any mining or other operations external to the manufacture and finishing of the steel, there is usually sufficient steam in excess of the miscellaneous requirements to supply 80 per cent or more of the total mill power.

The steam production from blast furnace gas in an American plant which has been in operation for about two years has averaged 3.67 lb. of steam per pound of coke used in the blast furnaces. This production is from the gas remaining after the use of a sufficient amount in the hot blast stoves. It is not, however, representative of the maximum that could be produced as the boiler plant load was not at all times sufficient to use all the gas that was available. An average of about 0.79 lb. of steam per pound of coke charged in the blast furnaces was required for operation of the turbo-blowers.

The load duration curve serves as a means for determining what proportion of the load can be carried with waste fuels and of the quantity of auxiliary fuel that will be required.

In any blast furnace plant instances occur occasionally when no gas is available from the furnaces and the auxiliary fuel system must therefore be sufficient to carry the entire plant load for a short period.

Stokers cannot be successfully operated in the same furnace with gas. This is in part due to the impossibility of rapidly varying the heat production on

the stoker to compensate for rapid fluctuations in the amount of gas available and in part to the air leakage through the stoker which defeats attempts to regulate properly the supply of air for combustion of the gas. It is difficult to protect the stoker against the heat of combustion of the gas at times when no heat is required from the stoker fires. Because of the above and of the absence of liquid or gaseous fuels which may be economically used pulverized fuel remains as the most practical solution. Recent systems of this kind are entirely automatic, the coal feed coming on whenever required and in sufficient quantity to compensate for deficiencies in gas supply.

Attention must be given to the proportions and arrangement of boiler furnaces for the combined burning of blast furnace gas and pulverized fuel. Because of the large volume of the products of combustion the power required to produce the draft becomes excessive at high ratings. Blast-furnace gas has a low flame temperature and is low in combustible. Though the physical limit of heat production per unit of furnace volume is probably very high it is necessary, in order to assure complete combustion, that this value be kept at a fairly conservative figure. For good results the heat liberation per cubic foot of furnace volume per hour should not exceed about 20,000 B.t.u. With powdered coal alone the heat liberation may be as high as 25,000 for maximum ratings, so that if the furnace is large enough for the gas fuel it will have a slight excess of volume for the coal. Some installations have been placed in operation with completely water-cooled furnaces and are intended to operate at very high rates of heat liberation. However, with the low flame temperature of blast furnace gas there is some possibility of trouble in maintaining combustion if such boilers are operated at low ratings.

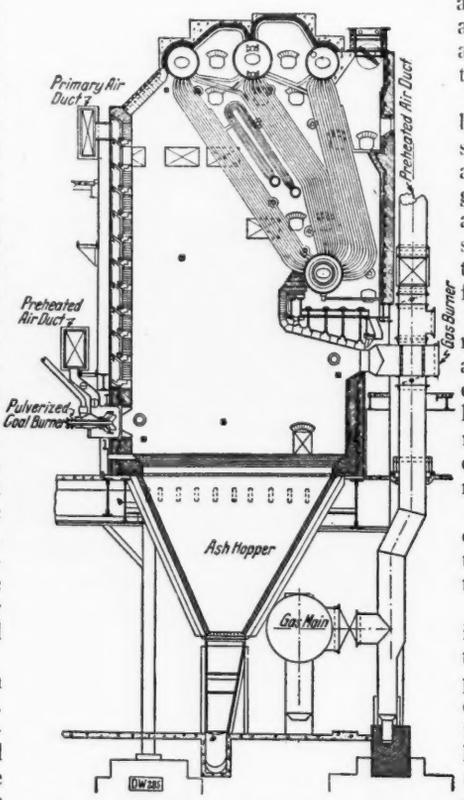
The arrangement of burners has been the subject of considerable discussion. In the earlier installations the pulverized fuel burners were generally placed at or near the top of the furnace and the gas burners lower down on the same side. With this arrangement there is a tendency for the pulverized coal to be blown against the boiler tubes by the rising stream of gases from the gas burner before combustion is complete. As a result of experience and further study the furnace here shown was designed and has given gratifying results both from the standpoint of efficiency and of operating behavior.

Because of the large amount of inert gas present in blast-furnace gas it is desirable that the two air-fuel streams be kept out of contact until combustion has progressed to a considerable degree. With a correct mixture of gas and air, combustion is practically complete about eight feet from the tip of the blast-furnace gas burner. The same is true of the turbulent type coal burner so that if the burners are placed in opposite walls with a distance in excess of 16 ft. between, the combustion of neither should be interfered with by the other.

The irregularity of blast furnace gas supply requires that the pulverized fuel system be exceedingly flexible. This dictates the use of a storage system with separate mills and feeders as the unit system does not respond quickly enough to the very rapid fluctuations in load nor can it be made to operate efficiently at very light loads.

Ability to pulverize and burn coke breeze in the blast-furnace gas boiler furnaces permits its disposal in a profitable manner. It also permits the generation of all steam and the utilization of all waste fuels in one boiler plant.

Many plants have installed waste-heat boilers at their open-hearth furnaces. Such installations were profitable when blast furnace gas was used inefficiently or not at all. Today the efficiency is



Furnace designed for burning gas and pulverized coal

such that practically all of the power required can be made from blast furnace gas. A disadvantage of the open hearth waste heat boiler lies in the fact that it is so frequently located at a considerable distance from the center of steam distribution and from the main blast furnace gas boiler plant.

It is generally considered that the straight regenerative cycle without recourse to reheating can be used up to pressures of about 450 to 500 lb. per sq.in. The use of pressures of 1,000 lb. or higher with reheating sufficient to maintain proper superheat in the turbines results in a material gain in efficiency, but because of the increased capital cost the economic gain is not great except with relatively high priced fuels or high load factor. In the case of the steel mill power plant where blast furnace gas constitutes part of the fuel the use of these higher pressures is not usually justifiable.

There are instances in which the excess power available from waste heat can be sold locally either to neighboring manufacturers or to a public utility company. In such cases, expenditures for higher efficiencies must be evaluated on the basis of the increased receipts.

Analysis shows that the cost of the regenerative cycle is no greater than that of the older systems using the exhaust from auxiliaries for feed heating. In addition, the operation of a properly designed regenerative cycle is entirely automatic and no special heat balancing devices are required. There is no loss of steam due to lack of balance so that the quantity of make-up water is small and can be supplied from a small evaporator plant. With such an arrangement, the boilers are operated entirely with distilled water and troubles from scale are eliminated.

This regenerative cycle can profitably be applied to the blast furnace and Bessemer converter turbo-blowers as well as to the turbo-generators. The diagram shows the heat cycle of the steam and power system of a recently constructed plant which has been in operation for over a year and has given satisfactory performance in all respects.

Much of the excessive fuel requirement in large mills is due to the losses attendant upon the distribution of steam over wide areas. In the older mills a large proportion of the auxiliary apparatus is steam driven and most of it can now be operated by more efficient means.

It appears impractical to eliminate entirely the need for steam at a relatively low pressure, 100 to 150 lb. in the steel mill.

This steam goes to uses from which it is impossible or impractical to return the condensate. If steam from the high-pressure boilers is passed through reducing valves the boiler plant make-up is greatly increased, requiring a much larger evaporator plant. With this arrangement the vapor from the make-up evaporator plant must be condensed with water from outside the steam cycle and the latent heat of the steam is therefore lost. If, however, an evaporator is used which will produce vapor at the desired pressure of 100 to 150 lb. this vapor may be used directly in the low-pressure steam system.

An interesting side-light on the development of steel mill power is the increase in size of units. In older installations boilers with 5,000 sq.ft. of heating surface or less were the rule, whereas recent installations contain boilers of 25,000 sq.ft. Blowing engines had a displacement of not more than about 40,000 cu.ft. per minute. Turbo-blowers in use today are not usually smaller than 60,000 cu.ft. and one is now under construction with a capacity of 110,000 cu.ft. per min. A few years ago turbo-generators of 5,000 kw. were considered large, and today units of 20,000 to 30,000 kw. are being installed.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Equipment for Directing Elevator Passengers Automatically

TO AUTOMATICALLY give elevator passengers information necessary in the rendering of efficient service, the Elevator Supplies Company, Inc., Hoboken, N. J., has developed a device known as the Rotoscope. This equipment consists, essentially, of a screen *A* installed on one side of the car, and on the opposite side a projector *B* with its operating mechanism, Fig. 2. The equipment may be located anywhere that will bring the screen in plain view of the passengers and the operator.

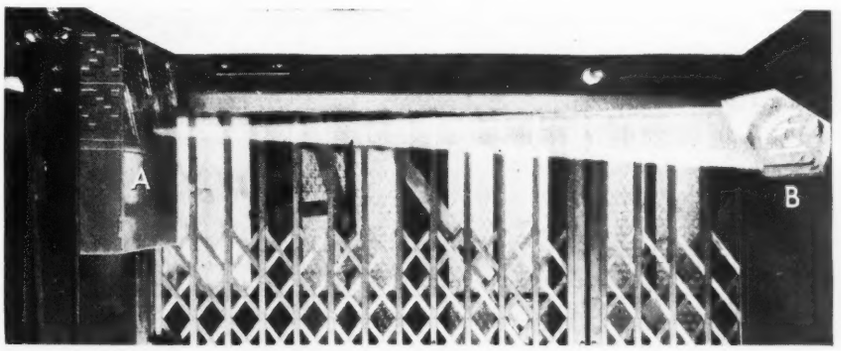


Fig. 2—Complete Rotoscope installation, showing the projector *A* and the screen *B*

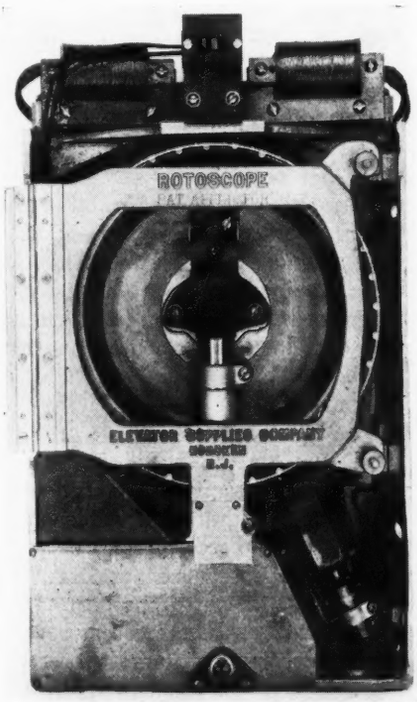


Fig. 1—Front view of projector mechanism, removed from its case

In the projector, Fig. 1, there is a film carrier that has 36 positions. Each can be used to carry a section of film with a message on it. When the car leaves a floor the announcement for the next floor is moved into position automatically in the projector and flashed on the screen, thus permitting the passengers to read the message and be prepared to leave at the next floor if they wish. Since there are 36 positions in the projector it is capable of flashing one indication per floor for an elevator traveling 36 floors, and can also be arranged for express service. Should the car be reversed in its travel, the Rotoscope also reverses and flashes the correct indication on the screen. The sections of film carrying the different floor indications can be easily and individually changed to suit changed conditions in the building.

The control of the mechanism, installed in the elevator-machine room, consists of a set of brushes traveling along a row of segments representing the different floors in the building. When the brushes make contact on the segments corresponding with a floor an electric circuit is completed that actuates the control mechanism on the control board, which, in turn, causes the projector in the elevator to function.

Among the applications the device may be put to is to announce the floor number in elevator cars. Where one company occupies a whole floor, the floor number and the company's name may be given. Where one firm occupies several floors, the floor number, the name of the company, and the department on each floor can be flashed on the screen. In department stores the floor number and the merchandise on the floor are indicated. In buildings that are the home offices of large companies, large bank buildings, large hotels, apartment houses, and other classes of buildings the screen announcement may be arranged to suit the particular class of service. The equipment can be operated on either 110-volt or 220-volt, 25- or 60-cycle, single- or three-phase alternating current, or on 110- or 220-volt direct current.

Mechanical Lubricators in Five Types

AMONG the features of a line of mechanical lubricators for industrial applications brought out by the Nathan Manufacturing Company, 250 Park Ave., New York, N. Y., are: Ease and accuracy of regulating the quantity of lubricant delivered; positive operation under all conditions; simple mechanical construction, eliminating all valves; uniform lubricant delivery at slow speeds; and wide range of pressures. Five different types (D, DSI, P, PK, and PS) are included.

Type D lubricator has a positive piston mechanism and visible piston

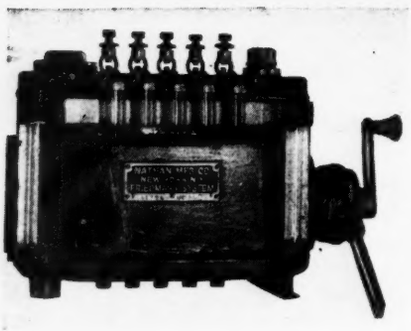


Fig. 1—Type DS1 lubricator with sight feeds

indicator. It is arranged for from 1 to 38 feeds, and is equipped with an oil reservoir and either ratchet or rotary drive for right-hand or left-hand rotation or both. Necessity for using a sight-feed instrument is eliminated, and the machine is recommended for equipment where an attendant is not available to check the amount of lubricant being delivered. It will work against pressures from 500 to 2,800 lb. A similar type, the model DS1, illustrated in Fig. 1, is distinguished from type D by the sight feed provided for observing the oil feed in the form of drops.

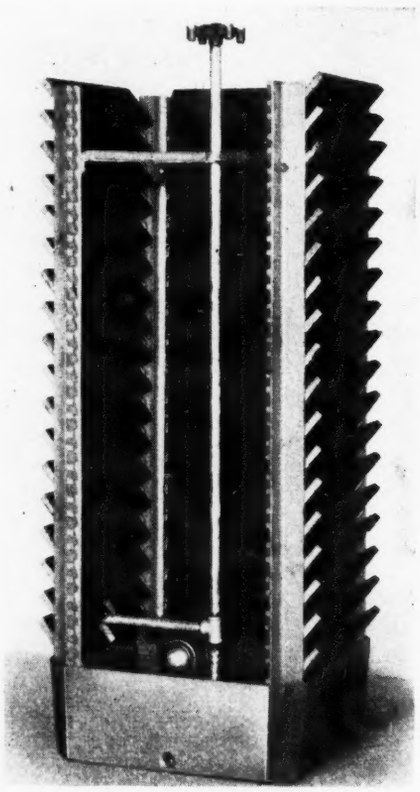
Smaller lubricators are available in types P, PK, and PS. Type P has from one to eleven feeds, but is not supplied with an oil reservoir. The rate of oil feed for each piston can be regulated from 0 to 0.010 cu.in. per piston stroke. The device adapts itself readily to all conditions of driving mechanism and piping. Type PK lubricator is similar in construction to type D, but is smaller and more compact. Type PS, shown in Fig. 2, is similar to type P, but is provided with a suction tube for connecting the lubricant to an oil reservoir already provided on the machine but not located in a convenient place for the lubricator drive. The ratchet feed is adjustable as required.

Fig. 2—Type PS lubricator with suction tube

Small Spray Cooling Tower

PARTICULARLY suitable for cooling jacket water of Diesel engines and for use in small refrigerating plants and other installations where the capacity required does not exceed 10 to 12 gal. per minute is the type G spray cooling tower recently introduced by the Marley Company, 1737 Walnut St., Kansas City, Mo.

Cast iron is used in the construction wherever possible, the water box, tower framework, and bracing being of that material. The louvers, of California redwood, are a slip fit in the corner posts, no screws or nails being employed to hold them in place.



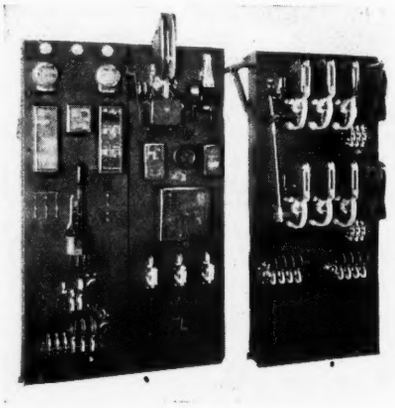
Tower with louvers removed from one side

No decking material is used. A group of spray nozzles (number and size depending upon capacity desired) is mounted on a central pipe a short distance above the top of the tower, as shown. An automatic float control valve in the base of the tower is standard equipment. Dimensions of the tower are, maximum width, 36 in., height, 7 ft. Water storage is 38 gallons.

Dry Rectifier for Switching Equipment

A COPPER-OXIDE rectifier instead of the field-flashing motor-generator set distinguishes a new design of automatic switching equipment for synchronous converters in mine service announced by the General Electric Company, Schenectady, N. Y.

A number of improvements over older models are incorporated, the most important being the copper-oxide rectifier, which is connected to the alternating-current power supply, thereby providing a definite source of power at correct polarity with which to flash the field. The field-flashing contactor and the main-field contactors are retained. The rectifier is small and is mounted on the back of the starting and running panel.



Automatic switching equipment with copper-oxide rectifier

Formerly, two relays were used to check the polarity and voltage conditions before allowing the converter to be connected to its load, and to protect it against reverse current after it was connected. These devices are now combined in one, which also uses a copper-oxide rectifier in its circuit. The combination eliminates one relay and leaves more space for the other equipment on the panel.

The equipment as a whole provides protection to the substation equipment in the event of the following abnormal conditions: Alternating-current and direct-current overcurrent; alternating-current undervoltage and reverse phase; direct-current reverse polarity; direct-current reverse power; incomplete start; overheated bearings and windings; single phase or unbalanced phase currents; overspeed; and wrong brush position.

NEWS of the FIELD

Spot News

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OPENING MOVES *in what will probably be a long fight between the Public Utilities Commission and the Potomac Electric Power Company were launched by the commission in a recent letter to the company stating that its proposal to retire its old steam plant at Fourteenth and B Sts., Washington, D. C., at a book cost of $2,463,000 will not be approved. The company obtained $3,600,000 from the government for the property, and the commission claims the profit of $1,137,000 all goes to the company instead of to consumers in reduced rates.*

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PLANS *for water power developments to cost $23,026,000 in Virginia and West Virginia were revealed in the amended application of the West Virginia Power Company filed last week with the West Virginia Public Service Commission. Two projects are proposed, one at Bull Falls with an installed capacity of 168,000 hp. and the other near Hinton with a capacity of 31,000 horespower.*

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OFFICIAL OPENING *of the only county-owned central station in the United States took place recently in Crisp County, Ga. With an initial installation costing $1,250,000, the plant will have an ultimate capacity of 20,000 hp. Water for running the plant is furnished from a 7,000-acre lake impounded by a dam across Flint River.*

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AN UNUSUAL *stream-gaging cable installation has just been completed by the United States Geological Survey across the Columbia River at The Dalles, Ore. With a clear span of 1,237 ft. and a clearance of 75 ft. above low water, this is one of the largest jobs of its kind ever erected. The cable is supported by a 54-ft. steel tower on each bank.*

Public Utility Power Production Gains Slightly During First Half of 1930

ELECTRIC POWER PRODUCTION for the first six months of 1930 by public utility power plants in the United States amounted to 48,207,000,000 kw.-hr., compared with 47,399,000,000 kw.-hr. for the corresponding period of 1929, an increase of 1.7 per cent, according to figures just released by the Geological Survey of the Department of the Interior. Compared with the first half of 1928, the 1930 output shows a gain of 14.2 per cent.

Total production of electricity by public utility power plants in June of this year was practically the same as in June, 1929. The curves of average total daily production of electricity below show that the demand for electricity during May and June was about the same as during the same months in 1929, and apparently show that the decrease in the demand for electricity has probably ceased. There are indications that probably about the normal seasonal increase in demand will be shown in the months to follow.

The decline in the daily production of electricity by the use of water power from May to June was small, even though drought conditions throughout the country increased during June.

According to the National Electric Light Association, total consumption of electric power was 37,826,364,000 kw.-hr. for the first six months of 1930, 1.7 per cent higher than the corresponding period of 1929 and 15.1 per cent above that for 1928. Total revenues of the light and power companies for the six months were 4 per cent higher than for the same period in 1929, and 12.7 above 1928.

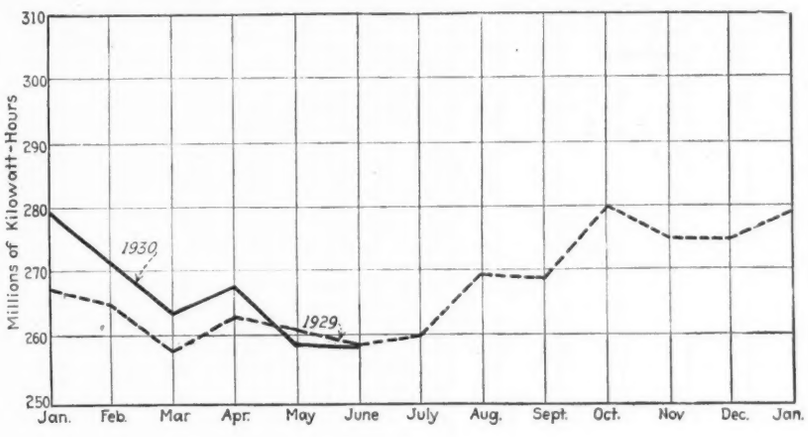
The consumption of electric power by small industrial concerns, stores, theaters, for street lighting, and corresponding uses, was 6.8 per cent above that for 1929, and 24 per cent above 1928. Large industrial plants, mines, quarries, and bulk power users consumed 2.2 per cent less in the six months just concluded than in the corresponding period in 1929, but the consumption by them was 10.3 per cent higher than for the first half of 1928. In view of the exceptionally high levels of industrial activity in the first half of 1929, the association considers this gain, in comparison with 1928, as of decided importance in relation to any interpretation that may be made of business conditions.

Start on Diablo Power House

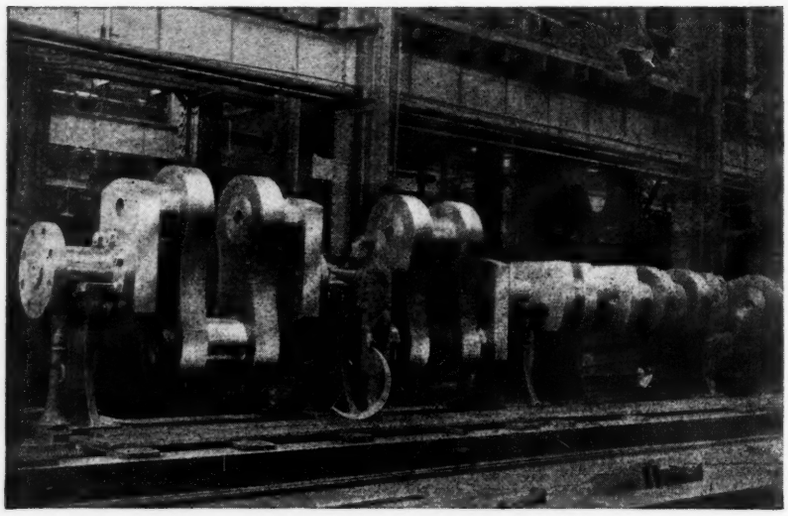
Excavation for Seattle's (Wash.) new power house at Diablo on the Skagit River will be started immediately by Rumsey & Jordan, contractors, who recently completed the power tunnel for this project at a cost of $750,000. The excavation will be made on the cost-plus basis, the contractors to receive 12½ per cent profit. This method of payment has been decided upon because the Engineering Department has some doubt as to the exact amount of earth to be removed.

The same firm has also been awarded a contract to build the surge tank at the power tunnel at a cost of $64,000.

Average daily production for the first half of 1930



HUGE DIESEL CRANKSHAFT



This built-up crankshaft is for a Sun-Doxford opposed-piston Diesel engine to be installed in a tanker. Each cylinder of the engine has three cranks and three connecting rods, one for the lower piston and two for the upper

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Arizona to Fight Boulder Dam; Plans Progress

That Arizona will fight the Boulder Dam project to the bitter end now seems certain despite rumors to the contrary, according to recent press dispatches. K. B. Pederson, Attorney General of Arizona, stated while in Washington last week that suit would be filed before the next session of the United States Supreme Court on grounds of unconstitutionality. The contracts signed by the Interior Department will provide insufficient funds to finance the project as required by law, said Mr. Pederson as one of his main arguments. The Comptroller General has been asked to rule against further expenditures for construction preliminaries until federal funds are more fully safeguarded. Arizona is retaining the Washington law firm of Covington, Burling & Rublee in its case.

Meanwhile railroad connections to Boulder Dam will be pushed immediately under a contract signed last week between the Union Pacific Railroad and the Interior Department. From its junction point with the subsidiary Los Angeles and Salt Lake line, the spur will carry through to the floor of Black Canyon over a track distance of nearly 30 miles. This road is divided into three sections. The first, running through to a point known as the summit, will be 29.84 miles long. The cost will be borne by the Union Pacific, which will be compensated through freight revenues. The second section will be a switch yard of 0.32 miles at the summit, toward which the government will pay 10 per cent of the construction cost and half the maintenance charges thereafter. Beyond here 7.13 miles of track goes down the steep incline to the damsite. The contract for this section has not been let, but probably will be contracted at a cost estimated around $1,600,000. Probably a cogged railway will be necessary. This will be under federal operation, since obviously no private firm would have any incentive to handle that part of the line.

Oregon Cities Lack Prior Rights to Water Powers

In the opinion of the Oregon state engineer, prior rights to the appropriation of water by municipalities, as defined by the laws governing such matters, extends only to appropriations for domestic purposes, and cities in this state may not exercise priority privileges in the applications for water permits involving the development of light and power projects. This interpretation of the Oregon water code was offered by Engineer Luper during a hearing before the reclamation commission in connection with the application of the Northwest Power Company for permits to appropriate water and develop hydro-electric units on the North Santiam River and Marion Lake, applicant being a subsidiary of the Pacific Northwest Public Service Company, of Portland.

Subsequent to what was supposed by the reclamation commission to have been final hearing in the matter of the Northwest Power Company application and the attendant protests filed by a number of municipalities the city of Salem now appears before the commission with a petition asking that the application of the power utility be denied on the grounds that the city desires to appropriate the water for the development of electricity, and cites an amendatory act passed by the 1929 Legislature to substantiate a claim for prior rights to the use of the supply being sought by the private utility. The state engineer holds that priority in this instance would apply in the event the municipality desired the water for purely domestic uses, but otherwise, the law does not differentiate.

The commission postponed final action pending further investigation.

Diesel Replaces Steam as Shipbuilding Declines

Disagreement persists concerning their relative efficiency and economy, but the Diesel engine has definitely taken the lead away from the steam turbine in new ship construction. A survey made by the Department of Commerce reveals that at the close of the June quarter 63 per cent of all new merchant tonnage under construction was in motor ships, compared with 60 per cent in the previous quarter and 50.5 per cent at this time last year. While motor-ship building of 1,920,505 gross tons now under way represent a decrease of 10,857 tons from the previous quarter, construction of vessels of other types showed a decrease of 197,337 tons to a total of 1,137,230 on June 30. At this time last year the construction of vessels to be run with internal-combustion engines totaled 1,432,000 gross tons, compared with 1,406,000 tons in all other types.

Declines in the aggregate horsepower of all types of marine engines building throughout the world were shown during the past quarter. For oil engines the world total at the end of June was 1,430,417 indicated horsepower, as against 1,559,955 at the end of March. For Great Britain and Ireland there was a decrease from 457,932 to 423,201; for Germany, from 257,955 to 233,576; Denmark, from 209,285 to 158,170; Sweden, from 100,295 to 91,460; Netherlands, from 100,996 to 88,330; Switzerland, from 106,950 to 78,890; and for the United States, from 44,892 to 31,075. In the same period, Italy's figure increased from 103,500 to 127,940, and Japan's from 84,400 to 91,275.

For reciprocating steam engines the total indicated horsepower for all countries fell from 506,227 to 426,093. For Great Britain and Ireland, there was a decline from 327,312 to 234,358; and for the United States, from 13,500 to 11,000.

The returns for the shaft horsepower of steam turbines show a decrease in the world total during the last quarter from 652,434 to 554,260. However, while the aggregate for Great Britain and Ireland fell from 321,469 to 233,760, that for the United States increased from 118,500 to 175,500.

Cities Service Plans Large Additions to Gas Lines

An extensive construction program for increasing the service capacity of the entire natural-gas pipe-line system of Cities Service Gas Company has just been announced. The expansion program includes the addition of 24 new compressor station units of 1,000 hp. each, or a total of 24,000 hp., to the compressor stations in Oklahoma, Texas, and Kansas which assist in transporting the natural gas along the lines which serve Wichita, Lawrence, Kansas City, and other northern markets.

The construction of new compressor stations at Blackwell and at Drumright in Oklahoma; an extension of the Oklahoma City 20-in. line from Dilworth, Okla., to a point south of Wichita; improvement of the Dilworth-Cambridge 16-in. line for high-pressure service; and the laying of fifteen miles of 16-in. pipe line from Independence, Kan., to Joplin, Mo., are included in the program.

Of major importance in the program of increasing capacity of the gas pipeline system is the addition of fifteen compressor station units, or a total of 15,000 hp., to the stations which transport the gas through the 20-in. line from the Texas Panhandle to Wichita, Kansas City, and adjacent territory. Two units each are being added to compressor stations at Pampa and Higgins, Tex.; Mooreland, Okla.; and Corwin, Matfield Green, and Ottawa in Kansas.

Construction is under way on the 32-mile extension of the Oklahoma City 20-in. line from Lilworth, Okla., to a point a few miles south of Wichita, where it will connect the Oklahoma City field with the company's distribution system serving northern markets.

The new compressor station under construction at Blackwell includes five units with a total of 5,000 hp. which will force gas from the Oklahoma City field to compressor stations at Cambridge and at Wichita. Additional compressor units may be added later to the Blackwell station.

The capacity of the company's 16-in. pipe line which transports natural gas from Seminole, Hughes, and Okfuskee counties in Oklahoma will be increased by a 4,000-hp. compressor station now under construction at Drumright. This line connects with the Texas line at Ottawa.

New 70-Mile Line for Ohio Edison System

Construction of a 70-mile high-tension transmission line, connecting the Akron system of the newly organized Ohio Edison Company with the $21,000,000 Toronto, Ohio, power development on the Ohio River, will be started at once, Vice-President A. C. Blinn announced last week. The project will cost $3,000,000 and will include the erection of a $750,000 substation which will be the most modern in this country.

This new line will give the Akron division three direct sources of power, in addition to the Akron Gorge plant. High-tension lines now connect Akron with the plant at Windsor, W. Va., and also with the system of the Cleveland Electric Illuminating Company, which has under construction a new plant at Ashtabula, Ohio, similar to the one operated at Avon, Ohio.

Announcement of the location of the general offices of the new Ohio Edison Company at Akron was also made.

Detroit Edison Plans to Rebuild Connors Creek

Preliminary work in connection with rebuilding the Connors Creek power plant of the Detroit Edison Company has been started. The tentative program includes construction of a new switch house, an addition to the present turbine room to accommodate two 60,000-kw. tandem turbine-generators, and the ultimate replacement of all present boilers and turbines.

The first section of the new switch house has been under construction for several months, and the structural steel is now being erected. The roof of the present power plant is being raised, and other preliminary building work has been started in connection with the replacement of present equipment. The turbine-room addition for the first two units will be started in August.

Plans are still in the formative stage, but the ultimate rebuilt plant, including the new addition, will probably contain fourteen new boilers and will have six 60,000-kw. turbine-generators and four 4,000-kw. house-service units. This will double the rated capacity of the present plant. The entire project will cost approximately $30,000,000 and will require seven or eight years to complete.

New General Course Offered at Southern California

A new four-year course in industrial engineering leading to the degree Bachelor of Science will be established at the University of Southern California with the opening of the fall semester, Philip S. Biegler, dean of the College of Engineering has announced.

"To meet the demand of industries the new course will be combined with studies offered in the Southern California College of Commerce for the purpose of fitting students to fill positions as superintendents and managers of manufacturing plants, and to enter engineering sales work," stated Dean Biegler.

Studies are so arranged under the new plan that a gradute may return to southern California for a fifth year and receive a degree in a specialized phase of engineering if he so desires.

News of Canada

Ontario installing tenth unit at Queenston—West Kootenay plans third development on Kootenay River—Edmonton steam tunnel completed

CONSTRUCTION WORK on the addition to the Ontario Hydro Electric Power Commission's Queenston development, where a tenth unit is being installed, is progressing satisfactorily. This unit, which is to have a rated capacity of 58,000 hp. under a head of 294 ft., will be similar, in most respects, to units Nos. 6 to 9 in the same development. Operating experience during the past few years has indicated the necessity of having an additional unit to provide spare capacity during periods of shutdowns of other units for maintenance work. When all ten units are available for service the plant capacity will be increased, although not to the extent of the full rated capacity of the unit. It is estimated that the increased continuous capacity of the plant will be some 12,000 horsepower.

The turbine is being built by the Dominion Engineering Works of Montreal. Only one change of importance is to be noted in the hydraulic equipment, namely, in the governor, which is of the Morris-Pelton type with motor-driven flyballs, the first with this type of drive used at Niagara Falls.

THE West Kootenay Power Company, operating in British Columbia, has completed plans for another great hydroelectric development in that province. The company proposes to erect a third plant on the Kootenay River two miles above Upper Bonnington to develop at least 30,000 hp. at first and probably more later on. With its third plant the West Kootenay development on the Kootenay River will be one of the most important in Canada. Already the company is producing 72,000 hp. at South Slocan, 60,000 hp. at Lower Bonnington, and 30,000 hp. at Upper Bonnington, a total of 162,000 hp. The new project will raise the total to almost 200,000 hp. At the same time the company is developing 30,000 hp. on the Adams River, east of Kamloops, and has plans to develop the Pend Oreille River, near the United States boundary, and create there one of the greatest single power units in the Dominion.

IN EDMONTON, Alberta, a tunnel has been completed to carry steam from the government central heating plant to the new administration building. The tunnel runs for about 200 ft. from the interior depths of the main capitol building to the street line, measuring 3½ ft. in diameter. From the end of the tunnel a pipe line will be run up the hill, connecting with the distribution plant in the new building.

Stevens Institute to Give Graduate Courses

For the first time in its 60-year history, the curriculum of Stevens Institute of Technology for the academic year 1930-1931 will include courses for graduate students. Stevens has heretofore offered a general unspecialized course in engineering and has given only the undergraduate degree in a course. Since the inauguration of President Harvey N. Davis a faculty committee has been investigating the field of graduate instruction. Following the recommendation of this committee the trustees and faculty have approved a program of graduate courses leading to the degree of master of science.

Graduate instruction is given during the day in the fields of electrical, mechanical, chemical, and civil engineering and in business administration. Research projects in the properties of steam, smoke abatement, and the measurement of engineering aptitudes are now in progress.

One course of particular interest will be given by Dr. William A. Shewhart, of the technical staff of the Bell Telephone Laboratories, Inc., on statistical theories and methods applicable to the economic control of quality in manufactured products. That course will deal with the theory of statistics; the application of modern statistical theory to the analysis, interpretation, and presentation of data, to the planning of physical investigations, to the development of economical production and inspection methods, and to the establishment of standards for quality.

Obituary

W. W. PATRICK, a director of the Foxboro Company, died suddenly, July 11, of pneumonia. He was one of the most widely known figures in the instrument business. He had been associated with the founders of the Foxboro Company since 1899. In 1908 he became New York district sales manager and held that post for 22 years. Mr. Patrick was also a prominent figure in the Association of Scientific Apparatus Makers of America. He was a director of the association and chairman of the industrial instrument section.

FRANK J. OAKES, general superintendent of the Dodge Works of Link-Belt Company, Indianapolis, Ind., died suddenly at his home, on July 19, of apoplexy. He was born Oct. 10, 1875, at Decatur, Ill., and entered the service of the Link-Belt Machinery Company, Chicago, in 1894, as repairman and general machinist. Mr. Oakes was well known in the mechanical engineering field. During the World War he was selected by the government as a designer and adviser on the manufacture of munitions. He was sent to Europe by the Link-Belt Company to investigate new mechanical inventions and to study chain-manufacturing processes. He was a pioneer in developing processes for the heat treatment of steel, and contributed valuable information to heat treaters as a result of his experiments. He also held patents on inventions in the chain industry and in other fields. Mr. Oakes was a member of the Society of Automotive Engineers, the American Society of Steel Treaters, the American Gear Manufacturers' Association, and several other engineering societies.

How's Business?

BUSINESS sentiment is bullish though several statistical indicators continue to fall. Our general index of business activity has fallen to 86.4% of normal from 90.5% a week ago. It was 114.5% a year ago. Most encouraging is a rise in commercial loans—business men are borrowing for fall activity. Copper and steel markets continued steady last week while steel production fell off. Though general trade continues to sag under the strain of depleted purchasing power during the past few months, increased employment in automobile and textile centers is encouraging. Low money rates coupled with advancing bond prices continue to encourage business. Gold continues to flow in large quantity from the country. The purchase of government securities in large quantities will serve to strengthen current credit conditions. The drought with the consequent increases in farm commodity prices may yet turn the wholesale commodity price level upward and stimulate advance buying.—*The Business Week*, Aug. 13.

Radford, Va., Diesel Plant Soon in Operation

City Manager W. H. Rankin, of Radford, Va., expects to have the electric system of the city connected with the new Diesel generating plant shortly. The new power plant has just been completed, at an approximate cost of $150,000. The Appalachian Electric Power Company has been furnishing power to the city for a long period, supplying all power needs, since the dam on Little River was destroyed. The Diesel Engine Manufacturing Company has installed the power plant, including three engines, and the city is to pay for it on the instalment plan. The sum that was paid for electric current is expected to pay for the new plant within a few years.

Personals

J. C. PATTERSON has been appointed electrical engineer in the power department of the eastern division of the Virginia Public Service Company, to fill the vacancy occasioned by the promotion of GEORGE E. KIDD to assistant division manager. Mr. Patterson was formerly connected with the General Electric Company and with the Appalachian Electric Power Company.

WILLIAM G. ANGUS, vice-president of the Dominion Power & Transmission Company, of Hamilton, Ontario, will join the administrative staff of the Power Corporation of Montreal when the Ontario Hydro-Electric Power Commission takes over that company this autumn. Mr. Angus has been with the Dominion Power & Transmission Company for 34 years and has been in charge of the light and power division for a considerable length of time.

LESLIE R. COFFIN, manager of the eastern district of the Puget Sound Power & Light Company and manager of the Washington Electric Company at Wenatchee, Wash., has been appointed manager of the central district of the Puget Sound Power & Light Company, Seattle, to succeed RICHARD M. BOYKIN, recently resigned to join the executive staff of the Electric Bond & Share Company, New York City.

ABBOT A. LANE, former mechanical engineer with Stevens & Wood, of New York City, is now associated with the Allied Engineers, Inc., of the same city.

A. R. SMITH has been appointed executive engineer of the turbine engineering department of the General Electric Company to succeed the late WILLIAM J. DELLES. Mr. Smith will retain his responsibility as engineer of the construction engineering department. He has been with the General Electric Company since 1897, and with the construction engineering department since 1908

H. S. BARTHOLOMEW, production and cost engineer, has been appointed directing head in a consulting capacity of the newly created cost engineering department of the Steel Founders' Society of America. Mr. Bartholomew resigned on July 15 as a member of the firm of Cooley & Marvin, cost engineers of Boston, Mass., with which he had been associated for a number of years.

JUDSON BIBB, recently with Mountain States Power Company, Albany, Ore., has resigned to accept a position as manager at Winnemucca, Nev., of the Western States Utilities Company. He succeeds O. R. MATHIAS, who has joined the Nevada Valleys Power Company, recently acquired by the Sierra Pacific Power Company, Reno, Nev., to manage the Lovelock, Nev., property of the company.

Business Notes

THE UNITED STATES CIRCUIT COURT OF APPEALS for the Third District has handed down a decision sustaining the opinion of the lower court in favor of the Underfeed Stoker Company of America in its suit against the American Engineering Company for infringement in the matter of high side wall tuyere blocks designed to minimize clinker adhesion.

COATESVILLE BOILER WORKS, Coatesville, Pa., have recently acquired the Middletown, Pa., plant of the Standard Steel Car Company. The addition of this new property makes the company's capacity the largest in America devoted exclusively to steel plate fabrication. The new property comprises approximately 40 acres of land and one-half million square feet of floor space.

FOOTE BROTHERS GEAR & MACHINE COMPANY, Chicago, Ill., announces the appointment of E. C. Wilson as assistant sales manager. Mr. Wilson has been in charge of the pricing group of the company's gear and reducer division, and was until 1929 assistant sales manager of the R. D. Nuttall Company.

THE FOXBORO COMPANY, Foxboro, Mass., has placed J. B. McMahon in charge of all field engineering service and direct sales at the home office. Mr. McMahon was formerly branch manager at Tulsa, Okla., and will be succeeded in that position by G. B. Lane, former manager of the Detroit office.

NATURAL GAS EQUIPMENT, INC., Los Angeles and San Francisco, Calif., is now distributing the products of Surface Combustion Company of Toledo, Ohio, and the Webster Engineering Company of Tulsa, Okla., in California, Oregon, and Washington. Similarly, the complete N.G.E. line will be distributed through all Surface Combustion and Webster branch offices in principal cities throughout the other states.

POOLE ENGINEERING & MACHINE COMPANY, Baltimore, Md., has appointed Neil Otey, formerly of the main office, as district manager of its Pittsburgh office, with headquarters at 245 Union Trust Building.

ROBINS CONVEYING BELT COMPANY, New York City, has been granted by the Adams Coal Machinery Company of Plainfield, N. J., the right to manufacture and sell the Adams avalanche chute, withdrawal chute, and floating chute to the different industries and operations where bulk materials such as coal, coke, stone, sand, and gravel are handled.

PITTSBURGH VALVE, FOUNDRY & CONSTRUCTION COMPANY, Pittsburgh, Pa., announces the appointment of J. F. Hanst as engineer and sales representative in the oil and gas division. It is also announced that I. W. Turner has been appointed to the company's New York sales office, of which Ray B. Felker is manager.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Fall meeting at French Lick Springs, Ind., Oct. 13-17. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual Pacific Coast convention at Portland, Ore., Sept. 2-5. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Welding Society. Fall meeting at the Congress Hotel, Chicago, Ill., Sept. 22-26. Secretary, M. M. Kelly, 33 West 39th St., New York City.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

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Trade Catalogs

CABLE EQUALIZERS — The Evans equalizer for use with compensating cables on high-rise elevators is fully described in the new bulletin of the Evans Elevator Equalizer Company, 122 East 42nd St., New York City.

PUMPS—In a handsome brochure, the Northern Pump Company, Minneapolis, Minn., features a complete line of rotary pumps of capacities from ½ to 5,000 gal. per min. for pumping water, gasoline, fuel oil, glucose, residuum, foam solutions, or any clean liquid. The illustrations bring out the many choices of spur gear and Herringbone gear reductions for motor, turbine and engine drives.

TRAVELING WATER SCREENS—In a 24-page, copiously illustrated booklet, No. 1252, the Link Belt Company, Chicago, Ill., describes the outstanding features of the latest design of clean water intake screen.

STEEL — In a 32-page, illustrated booklet, Littlefield Brothers, Cincinnati, Ohio, presents their conception of plate- and sheet-steel fabrication and erection. A section of the publication is devoted to helpful pointers on plate- and sheet-steel construction.

GAS BURNERS—An interesting and useful catalog has just been issued by the Lee B. Mettler Company, 406 South Main St., Los Angeles, Calif., covering the entire line of Mettler gas burners. Included in the catalog is a description of the latest development of the company, the Mettler full automatic conversion burner.

CONVEYORS—A new catalog, No. 202, on bulk material-handling conveyors has just been published by the Chain Belt Company of Milwaukee, Wis. This book gives complete engineering data with illustrations on bucket elevators of all types, super-capacity elevators, bin gates, track hoppers and feeders, steel apron and pan conveyors, weigh larries, and screw conveyors.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard...	New York.....	$2.10 @$2.30
Kanawha.....	Cincinnati.....	.90 @ 1.10
Smokeless.....	Cincinnati.....	1.75 @ 2.00
Smokeless.....	Chicago.....	2.00 @ 2.25
West Kentucky...	Louisville	.85 @ 1.25
Steam.....	Pittsburgh.....	1.50 @ 1.60
Gas Slack.....	Pittsburgh.....	.90 @ 1.10
Big Seam.....	Birmingham....	1.60 @ 1.75
Anthracite		
(Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat.....	New York.....	$3.00
Barley.....	New York.....	1.15 @ 1.40

FUEL OIL

New York—Aug. 7, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—July 30, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.470 per bbl.; 28@30 deg., $1.545 per bbl.; 30@32 deg. $1.625 per bbl.; 32@36 deg., gas oil, 4.28c. per gal.; 38@40 deg., distillate, 4.65c. per gal.

Pittsburgh—Aug. 6, f.o.b. local refinery, 34@36 deg., fuel oil, 3.12½c. per gal.; 36@40 deg., 3.25c.

Philadelphia—Aug. 3, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — July 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Aug. 4, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., $0.90 per bbl.

Boston—Aug. 5, tank-car lots, f.o.b., 12@14 deg., Baumé, .033c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Aug. 2, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Flagstaff—U. S. Property & Disbursing Officer, Army Dept., State Capitol Bldg., Phoenix, will soon award contract for the installation of water, sewer and electric light systems, also construction of warehouse, administration building, power house, etc. at Fort Alexander M. Tuthill here. Estimated cost $100,000.

Ark., Paragould—City, plans an election Sept. 21 to vote $125,000 bonds for the construction of municipal light, heat and power plant. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., is engineer.

Calif., Los Angeles—C. C. C. Tatum Building Income, Fidelity Bldg., Los Angeles, is having plans prepared for the construction of a hotel and apartment building on West 7th St. Estimated cost $1,500,000. C. F. Plummer, Story Bldg., is consulting architect.

Calif., Pasadena—City awarded contract for boilers for addition to generating works of Muny light and power plant to Consolidated Steel Corp., 1200 North Main St., Los Angeles, $123,151.

Ill., Chicago—Chicago Worlds Fair 1933, 160 North LaSalle St., is having plans prepared for an electrical group of buildings at Lake Front. Estimated cost $2,000,000. Private plans.

Ky., Bowling Green—Western Kentucky State Teachers College, awarded contract for the installation of a 400 hp. boiler and equipment for heating system to H. Netherton & Co., 114 North 5th St., Louisville. $17,042.

Mass., Cambridge (Boston P.O.)—Cambridge Industrial Trust, 25 State St., had plans prepared for the construction of a power house. Estimated cost $40,000. W. A. Hall, 80 Boylston St., Boston, is engineer.

Mass., Holyoke—Holyoke Water Power Co., is having preliminary plans prepared for the construction of a hydro-electric power plant at South Hadley Falls or Appleton St. Estimated cost to exceed $150,000. Private plans.

Mass., Taunton—Electric Light Commission, awarded contract for the construction of a substation and installation of underground wires; also power station to W. Barker, 4 Cohannet St. Estimated cost $40,000 and $50,000 respectively.

Mich., Rogers City—Rogers City Electric Light & Power Co., R. B. Henley, Secy. and Treas., will soon award contract for waterworks improvements including reservoir, pumping station, two electrically operated centrifugal pumps, etc. Hoad, Decker, Shoecraft & Drury, Ann Arbor, are engineers.

Minn., Olivia—City, M. Erickson, clk, will soon award contract for a sanitary sewerage system including sewage disposal plant, tanks, pumps and motors, etc. Estimated cost $32,000. Druar & Milinowski, 904 Globe Bldg., St. Paul, are engineers.

Mo., Independence—City is having plans prepared for extensions and improvements to power plant including boilers, stokers, turbine, etc. Estimated cost $115,000. Black & Veatch, 700 Mutual Bldg., Kansas City, are engineers.

Mo., Kansas City—Kansas City Power & Light Co., 14th St. and Grand Ave., will soon award contract for superstructure of a 30 story office building at 14th and Baltimore Sts. Estimated cost $2,500,000. Holt, Price & Barnes, 2500 Telephone Bldg., are architects.

N. J., Jersey City—Mongiello Bros., 625 Comminupaw Ave., are receiving bids for the construction of a 100 x 100 ft. ice plant. Estimated cost $40,000. C. H. Ziegler, 26 Journal Sq., is architect.

O., Akron—Bd. of Education, awarded contract for the construction of a 3 story, 70 x 282 ft. high school, including 46 x 88 ft. boiler house at Talmadge Ave. North, to A. F. Wendling Co., Massillon. Estimated cost $350,000.

O., Elyria—City, J. N. Eidt, Safety Service Dir., will receive bids until Aug. 15 for the construction of an ejector station, including equipment, etc., on Pine St. Estimated cost $20,000. G. B. Goscoique, Leader Bldg., Cleveland, is engineer.

Okla., Westville—City of Siloam Springs, Ark., is having preliminary plans prepared for the construction of a hydro-electric power plant on the Illinois River near here. Estimated cost $200,000. V. H. Cochrane, Wright Bldg., Tulsa, is engineer.

Ore., Portland—Portland Sports Arena Inc., T. W. Ross, Pres., awarded contract for the construction of a sports arena to include 180 x 190 ft. ice floor, etc., at First, Williams and Hassalo Sts., to L. W. Hanson Construction Co. Estimated cost $400,000.

Ore., Ten Mile—J. G. Barnes, J. Rathkey and C. Powell, plan the construction of an electric light and power plant on Ten Mile Creek to include power dam, power house, generating and distributing machinery, etc. Engineer not selected.

S. D., Pierre—City, c/o R. Baker, Engr., will receive bids until Aug. 15 for addition to power plant to house two new engines. Estimated cost $125,000.

Tex., Fort Worth—Texas Ice & Refrigeration Co., c/o C. Goodfellow, plans the construction of a 1 and 2 story produce market. Estimated cost $500,000.

Tex., Waco — U. S. Veterans Bureau, War Dept., Arlington Bldg., Washington, D. C., plans the construction of a group of hospital buildings, to include nurses' home, boiler house, etc., here. Estimated cost $1,200,000.

Va., Newport News — Bureau of Yards & Docks, Navy Dept., Washington, D. C., is having plans prepared for first unit of system of modern buildings at Hampton Roads Naval Training Station. Estimated cost $600,000. Total cost $6,000,000.

Vt., Charlestown—Village of Barton, awarded contract for addition to power plant to C. D. Marsh Construction Co., Woodsville, N. H. Estimated cost to exceed $40,000.

Ont., Auroa — Town plans the construction of a 1 story, 100 x 150 ft. hockey arena. Estimated cost $25,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are engineers.

Ont., Guelph—City plans the construction of a coal gas retort, vertical type in connection with gas plant. Estimated cost $150,000. N. S Nicklin, City Hall, is engineer.

Ont., Ottawa—Dept. of Railways & Canals, J. W. Pugsley, Secy., will receive bids until Aug. 18 for surge tank, penstock breeching and connections for hydro-electric plant.

Ont., Toronto — Toronto Electric Commissioners, 225 Yonge St., awarded contract for alterations and additions to sub-station at Ruskin and Edwin Sts. to A. W. Holmes, 6 Hayden St. Estimated cost $50,000. P. Hart, 225 Yonge St., is engineer.

Equipment Wanted

Boiler and Stoker—Cleveland, O.—Dept. of Welfare, Ninth and Oak Sts., H. H. Griwold, Dir., Columbus, will receive bids until Aug. 22 for one 300 hp. boiler and stoker for Cleveland State Hospital, here.

Pump—Palmdale, Calif.—Palmdale Irrigation Dist., will receive bids until Aug. 22 for furnishing and installing one 1,350 g.p.m. turbine pump with motor and 900 g.p.m. horizontal booster pump with motor for proposed waterworks improvements.

Pump—Dorchester, Mass.—Dept. of Public Works, City Hall, Boston, will receive bids until Aug. 20 for a motor driven sewage pump for Calf Pasture pumping station here.

Pump—Temple, Tex.—City plans the installation of a 2000 g.p.m. electric pump, etc. in connection with waterworks at River station.

Pumping Equipment—Detroit, Mich.—Dept. of Water Supply, Randolph St., equipment for pump house, filter buildings, etc., at new Springwells Water Station.

Pumping Units, Transformers, Motors, etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Aug. 20 for pumping units, transformers, motors, etc.

Pumps — Dupo, Ill. — City will receive bids about Oct. 1 for two 100 to 800 g.p.m. vertical centrifugal pumps direct connected to 20 hp., 220 v. 3 ph., 60 cycle 2 speed vertical squirrel cage motor, etc., for proposed sewage treatment work. Estimated cost $99,865.

Industrial Projects

Ariz., Ft. Huachuca—Arizona Imperial Mines Co., M. R. V. Baumkirchner, Pres., plans the construction of a 200 ton flotation plant, 1500 hp. power house, new compressor and hoist.

Ill., Chicago—H. P. Henschien, 59 East Van Buren St., Archt., will soon receive bids for a 2 and 3 story, 265 x 345 ft. sausage factory at Randolph and Carpenter Sts. for Richter Food Products Co., 2910 Armitage Ave. Estimated cost $500,000.

Ill., Chicago — Vortex Cup Co., 421 North Western Ave., awarded masonry and carpentry contracts for 4 story factory for the manufacture of paper drinking cups. Estimated cost $100,000.

N. J., Harrison—J. A. Finegan, 776 Broad St., Newark, Archt., will receive bids about Oct. 1 for the construction of a 1 and 2 story addition to factory for the manufacture of steel and wire products on Middlesex St., for Driver-Harris Co., Middlesex St., Harrison. Estimated cost $250,000.

N. J., Linden—Warren & Wetmore, 16 East 44th St., New York, N. Y., Archts., are receiving bids for the construction of a 1 story, 142 x 225 ft. carpet factory, for John T. Norman, Inc., 400 Madison Ave., New York, N. Y. Estimated cost $100,000.

O., Geneva—American Fork & Hoe Co., G. B. Durrell, Pres., B. F. Keith Bldg., Cleveland, awarded contract for a 2 story, 53 x 251 ft. factory here, to Rice-Jones Co., Union Bldg., Cleveland. Estimated cost $75,000.

O., Willoughby—Ohio Rubber Co., manufacturers of mechanical rubber goods and specialties, awarded contract for the construction of a 1 story, 120 x 480 ft. addition to factory to H. K. Ferguson Co., Hanna Bldg., Cleveland. Estimated cost $100,000. Machinery and equipment to cost $500,000 will be required.

Wash., Longview—Wyerehauser Timber Co., A. L. Raught, Mgr., will soon start work on a 150 ton sulphite pump mill.

Wash., Tacoma—St. Regis Paper Co., acquired the plant of the Union Bag & Paper Co., and plans extensions and improvements, also erection of a large mill. Estimated cost $2,000,000.

Wis., Milwaukee—Milwaukee Gear Co., 1222 3rd St., is receiving bids for a 1 and 2 story, 200 x 100 x 200 ft. factory on South Pierce St. Private plans.

Wis., Milwaukee—Moise Steel Co., 447 Virginia St., awarded contract for excavation, etc., for a 1 story, 73 x 225 ft. factory on 35th Ave.

Ont., Belleville—Budweiser Brewery Co. of Canada, Ltd., awarded contract for rebuilding plant destroyed by fire to Patterson Construction Co. Estimated cost $50,000. New machinery and equipment will be installed.

Ont., Guelph—Guelph Carpet & Worsted Spinning Mills Ltd, awarded contract for alterations and extensions to plant to Ball Bros., 33 King St. E., Kitchener. Estimated cost $50,000.

Ont., New Toronto—Anaconda American Brass Ltd., will build 1 story, 70 x 450 ft. and 1 story, 98 x 100 ft. additions to plant. Estimated cost $200,000. Private plans. Work will be done by day labor.

Ont., Penetanguishene — Dominion Stove & Foundry Co., manufacturers of "Spencer" hot water and steam heating boilers, plans extensions and improvements to plant including moulding shop. Estimated cost $75,000. Private plans. Special machinery, patterns and equipment will be required.

Ont., Salte Ste. Marie—Algoma Steel Corp. Ltd, J. D. Jones, Mgr., 503 Queen St. E., plans the construction of a 1 story railmill. Estimated cost $1,250,000. Private plans. Contracts awarded for structural steel, steel traveling crane and equipment.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES continue to decline, though there were no major changes during the last month. Structural steel at Pittsburgh continues to be quoted at $1.65 per 100 lb. Price declines of material on this page are in rawhide lacing, structural steel at warehouse, linseed oil, and babbitt metal.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net)†60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%

	Air—Best grade		
¾-in., per ft.	3-ply	$0.30	4 ply $0.36

	Steam—Discounts from List		
First grade 40%	Second grade 45%	Third grade	50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting in quantities of about ½ doz. rolls:

Best grade 50% Second grade 60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING
- For cut, best grade, 40%; 2nd grade, 50%.
- For laces in sides, best, 54c. per sq.ft.; 2nd, 46c., net.
- Semi-tanned, cut, 40%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.10 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.13½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.146	$0.164	$0.131

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	2.90

*This price is for full kegs; broken-kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	49.00
Commercial genuine, intermediate grade	36.00
Anti-friction metal, general service	31.00
No. 4 babbitt, f. o. b.	10.25

COLD-FINISHED STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.35
Flat or square	3.90	4.15	3.85

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	55%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1¼	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller.. $0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3¼ to 4 in.. .10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$26.00	$42.00	$115.00	$143.00
No. 12 solid....	41.00	41.75	117.00	166.00
No. 10 solid....	57.00	72.00	137.00	189.00
No. 8 stranded..	91.00	115.00	220.00	295.00
No. 6 stranded..	135.00	163.00	295.00	.....

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. New York warehouse shipment. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
¼	$58.30	$8.33	$4.79	$53.27	$7.21	$4.38
⅜	74.34	10.97	6.84	67.55	9.49	6.25
½	106.55	16.24	8.90	96.50	14.04	8.14
¾	144.16	21.97	12.48	130.57	19.31	11.47
1	172.37	29.31	15.41	156.11	25.76	14.17
1¼	231.91	54.71	20.55	210.04	47.20	18.90
1½	366.67	87.91	29.36	332.10	77.27	27.01
2	479.50	234.10	44.04	434.29	205.74	40.50
2½	603.84	516.92	58.74	549.47	454.09	54.02
3	736.89	597.18	73.41	672.47	524.78	67.50
3½	858.58	904.12	110.00	783.52	794.50	101.23
4	1000.55	1255.26	121.13	913.08	1103.08	111.37
5	1298.01	1560.33	176.12	1184.54	1371.20	161.93
6						

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$15.00
No. 16 cotton reinforced heavy		19.00
No. 18 cotton reinforced light		12.00
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		13.00
No. 16 cotton Canvasite cord		15.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$64.00	*71.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	92.00	*101.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List Each	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%

Discount Without Contract—Renewals:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%

Discount With Contract—Fuses:
Broken cartons..... 5%
Unbroken cartons..... 20%
Ten unbroken cartons..... 36%

Discount With Contract—Renewals:
Broken cartons..... Net list
Ten unbroken cartons..... 36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.80
0–30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	.....	.....
60	A 21	.20	...	.....	.....
100	A 23	.35	...	.....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.40	$7.20	$7.80	$14.00
12	7.50	9.05	10.10	17.60
10	10.20	11.90	13.10	23.60
8	14.80	17.40	19.00	34.80
6	.....	.....	26.50	.....
4	.....	.....	39.00	.....
2	.....	.....	55.40	.....
1	.....	.....	91.00	.....
0	.....	.....	98.00	.....
00	.....	.....	117.00	.....
000	.....	.....	140.00	.....
0000	.....	.....	171.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb.
Wire solder, in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Soldering paste, 2 oz. cans..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:
Standard package..... 40%
Less than standard package..... 35%